EXHIBIT 1

Port of Seattle

July 12, 2018

Ravi Sanga
U. S. Environmental Protection Agency
Region 10
1200 Sixth Avenue, Suite 900, M/S ECL-115
Seattle, Washington 98101-3140

Re: Dispute Resolution for Harbor Island East Waterway Feasibility Study

Dear Mr. Sanga:

On behalf of the Port of Seattle (Port), I am writing to initiate dispute resolution under Section XV of the EPA/Port Administrative Settlement Agreement and Order on Consent for Supplemental Remedial Investigation/Feasibility Study for the East Waterway Operable Unit of the Harbor Island Superfund Site (ASAOC).

We received your letter dated June 28, 2018 approving the Port's draft Final Feasibility Study (FS), on the condition that "the exact editing revisions shown on the attached tables and in the enclosed Appendix A Part 1 be made to the FS." It is this condition that we dispute. Specifically, the Port requests dispute resolution to resolve two of the directions provided in your comments on the Final FS.

First, the Port objects to the edits you have directed the Port to make in Appendix A of the FS.

Second, the Port objects to the requirements that "all references to the Washington State Department of Ecology developed natural background and practical quantitation limit values" be deleted, along with all "[r]eferences to Ecology guidance as a basis for any decisions made by the EPA."

After working cooperatively with EPA on the development of an FS Appendix A that lays out pathways to compliance with the requirements of Washington's Sediment Management Standards, we have now been told that we must change the document to conform to an edited version attached to your email that essentially rewrites the Appendix. The justification given in your letter is that the changes to Appendix A are needed "in order to correctly characterize cleanup projections and the potential application of State guidance and laws." We disagree that the required edits provide a correct characterization of cleanup projections, and we disagree with your assertion that the edits correctly characterize how Washington State laws, regulations, and guidance could apply to the East Waterway.

In the interest of transparency to the public and in order to be consistent with CERCLA laws, regulations, and guidance, we believe that the final FS must fully and accurately describe the state and federal regulatory framework, as well as the results of the many years of data collection and analysis that have already been performed.

This dispute could be resolved without further negotiation if EPA could accept the draft Final FS as it was submitted on November 3, 2017. If EPA is not amenable to that approach, we request an extension to the 14-day negotiation period described in Section XV of the ASAOC in order to provide a written submission detailing our concerns and to schedule a meeting with EPA's decision-maker in the dispute resolution process.

The Port has worked cooperatively with EPA's Superfund Program on East Waterway issues for the last two decades. This includes work under a prior supplemental remedial investigation order as well as a substantial interim sediment cleanup performed under a separate removal action order. We anticipate continuing to work cooperatively with EPA into the future. It is a measure of the seriousness of our concerns that we have now, for the first time, initiated the dispute resolution process.

I look forward to hearing from you in order to schedule a meeting date and a deadline for our written submission.

Sincerely,

Brick Spangler
Senior Environmental Program Manager

cc: Richard Mednick, EPA Office of Regional Counsel
Shawn Blocker, EPA Region 10
Dan Berlin, Anchor QEA LLC
Tom Wang, Anchor QEA LLC
Jeff Stern, King County Department of Natural Resources
Debra Williston, King County Department of Natural Resources
Pete Rude, Seattle Public Utilities
Elizabeth Black, Port of Seattle
Kristie Elliott, King County Prosecuting Attorney's Office
Tad Shimazu, Seattle City Attorney's Office

EXHIBIT 2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 155
Seattle, WA 98101-3123

OFFICE OF
ENVIRONMENTAL
CLEANUP

JUN 2 8 2018

Mr. Brick Spangler
Environmental Program Manager
Port of Seattle
PO Box 1209
Seattle, Washington 98111

Dear Mr. Spangler:

The U.S. Environmental Protection Agency has reviewed the draft Final Feasibility Study submitted by the Port of Seattle on November 3 2017, as part of the Supplemental Remedial Investigation and Feasibility Study for the East Waterway Operable Unit of the Harbor Island Superfund Site. The EPA approves of this document upon the specified conditions that (1) the exact editing revisions shown on the attached tables and in the enclosed Appendix A Part 1 be made to the FS; and (2) there be no other changes made to the FS.

The EPA is requiring removal of all references to the Washington State Department of Ecology developed natural background and practical quantitation limit values. References to Ecology guidance as a basis for any decisions made by the EPA must also be removed.

The EPA is further requiring significant revisions to Appendix A Part 1 "Compliance with Sediment Management Standards" in order to correctly characterize cleanup projections and the potential application of State guidance and laws.

In addition, the EPA is requiring the recalculation of cancer and non-cancer risks for cPAHs based on the revised IRIS toxicity values for benzo[*a*]pyrene established by the EPA in 2017. This includes making the appropriate changes to text, tables, and figures in Section 3 and any other affected sections of the draft FS. If changes result in the cancer risk dropping below 10^{-6} for a given pathway, contact the EPA to determine whether changes in remedial action objectives or preliminary remediation goals and remedial action levels are needed before resubmission of the draft FS.

Within 30 days upon receipt of this notice, the final corrected version of the draft FS must be submitted to the EPA. Should you have any questions, I can be contacted at (206) 553-4092, or by email at sanga.ravi@epa.gov. Inquiries from legal counsel should be sent to Richard Mednick at (206) 553-1797 or mednick.richard@epa.gov.

Sincerely,

Ravi N. Sanga
Remedial Project Manger

cc: Mr. Dan Berlin, Anchor QEA LLC
Mr. William Gardiner, U.S. Army Corps of Engineers
Ms. Kayla Patten, U.S. Army Corps of Engineers
Mr. Pete Rude, Seattle Public Utilities
Ms. Rebecca Rule, U.S. Army Corps of Engineers
Mr. Jeff Stern, King County Department of Natural Resources
Mr. Tom Wang, Anchor QEA
Ms. Debora Williston, King County Department of Natural Resources

EXHIBIT 3

APPENDIX A – SUPPLEMENTAL INFORMATION FOR SELECTION OF PRGS

EAST WATERWAY OPERABLE UNIT FEASIBILITY STUDY

Prepared for

Port of Seattle

Prepared by

Anchor QEA, LLC

720 Olive Way, Suite 1900

Seattle, Washington 98101

November 2017

APPENDIX A TABLE OF CONTENTS

PART 1: COMPLIANCE WITH SEDIMENT MANAGEMENT STANDARDS

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~~Figure 2 Conceptual Cross Section Showing Maximum Possible Remediation for Terminal with Keyway~~

1 INTRODUCTION

The Feasibility Study (FS) for the East Waterway (EW) Operable Unit (OU) has been developed under the regulatory framework of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Consistent with CERCLA requirements, the selected alternative must substantively comply with applicable or relevant and appropriate requirements (ARARs), which include the Washington State Sediment Management Standards (SMS). The SMS are the Washington State standards for remediating sediments under the Model Toxics Control Act (MTCA). This appendix provides a brief description of~~describes~~ the methods and procedures for establishing cleanup levels under the SMS and~~,~~ ~~and also discusses~~ how the EW ~~selected EW~~ alternatives developed under CERCLA ~~-~~will comply with SMS requirements.

The preliminary remediation goals (PRGs) presented in Section 4 of the FS were developed following a process consistent with the ~~to comply with the~~ SMS for determination of cleanup levels[1] under Washington Administrative Code (WAC) 173-204-560. The SMS cleanup levels are ~~determination is performed by~~ based on risk-based threshold concentrations, background concentrations, or practical quantitation limits. ~~Similar to CERCLA, there are lower and upper acceptable risk levels for both human health and ecological risks.~~ Under SMS, cleanup levels are based on the lower ~~determining the~~ sediment cleanup objectives (SCO; discussed in Section 2 of this appendix) and the upper cleanup screening levels (CSL; discussed in Section 3 of this appendix). The cleanup levels are initially set at the SCO. If the SCO is not technically possible to attain, or would result in net adverse environmental impacts, then the cleanup level ~~can~~ may be adjusted up to the CSL. ~~For several contaminants of concern (COCs) in the FS, the SCO has been established at natural background or practical quantitation levels (PQLs), but the CSL has not been established because regional background has not been determined for the EW area~~As described in Sections 2, 3, and 4, total polychlorinated biphenyls (PCBs) and dioxins/furans currently have cleanup levels based on natural background concentrations, which may be difficult to achieve based on the best-estimate predictions of sediment concentrations in the FS (e.g., see FS Section 9). Under

[1] For purpose of this appendix only, ~~T~~the SMS term "cleanup level" is considered analogous to the CERCLA term "PRG" used in the main text of the FS. This appendix sometimes uses the term "cleanup level" for consistency with the SMS. In other contexts, these terms may not have the same meaning.

both CERCLA and SMS there are provisions to address the influence of site-specific factors including the consideration of new information.~~In the absence of regional background values, cleanup levels (i.e., PRGs) for these COCs are based on the SCO in the EW FS. For some of these COCs, the SCO is not technically possible to achieve. As described in Sections 2, 3, and 4, total polychlorinated biphenyls (PCBs) and dioxins/furans currently have cleanup levels based on unattainable natural background or PQL concentrations, which may be difficult to achieve based on the best-estimate predictions of sediment concentrations in the FS (e.g., see FS Section 9).~~[2]

Based on preliminary evaluations, the EW OU cleanup is expected to comply with MTCA/SMS for protectiveness of human health for direct contact (remedial action objective [RAO] 2), protection of the benthic community (RAO 3), and protection of higher trophic level organisms (RAO 4) by achieving the PRGs for these RAOs. Following source control and remediation efforts, surface sediments in the EW OU are not currently predicted to attain all natural background-~~ or PQL-~~based PRGs for protection of human health for seafood consumption (RAO 1), due to modeling assumptions about the ongoing contribution of elevated concentrations from diffuse, nonpoint sources of contamination that contribute to regional background concentrations. However, ~~achieving~~addressing compliance with the MTCA/SMS ARARs may occur in one of ~~two~~three ways:

- Post-remedy monitoring may demonstrate sediment concentrations lower than currently predicted, and PRGs identified in this FS may be attained for certain chemicals in a reasonable restoration timeframe. If necessary, the restoration timeframe needed to meet the PRGs could be extended beyond 10 years if consistent with CERCLA~~ with the substantive requirements of a Sediment Recovery Zone (SRZ) as defined by SMS (see Section 5 of this appendix)~~.
- Sediment cleanup levels (SCLs) may be adjusted upward ~~once~~if EPA-approved regional background levels are established for the geographic area of the EW (see Section 4 of this appendix). Considering that ~~a~~such regional background values ha~~s~~ve not yet been determined for the EW, such adjustments could occur in the Record of Decision (ROD) ~~(before remediation)~~ or subsequently as part of a ROD amendment or

~~[2] Note that none of the alternatives is predicted to achieve the SCO for these chemicals; therefore, this appendix applies equally to any of the alternatives, if selected.~~

Explanation of Significant Differences (ESD)~~ (during or after remediation)~~. Consistent with the bullet above, the restoration timeframe needed to meet the SCLs could be extended beyond 10 years if consistent with CERCLA ~~the substantive requirements of an SRZ as defined by SMS~~.

- ~~In addition, f~~Following remediation and long-term monitoring, if the U.S. Environmental Protection Agency (EPA) determines that no additional practicable actions can be implemented under CERCLA to meet certain MTCA/SMS ARARs, EPA may issue a ROD Amendment or ESD providing the basis for a technical impracticability (TI) waiver for specified MTCA/SMS ARARs under Section 121(d)(4)(C) of CERCLA, 42 U.S.C. § 9621(d)(4)(C).

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Because it is not known whether, or to what extent, the SMS ARARs for total PCBs and dioxin/furans will be achieved in the long term, ~~or the timing of a potential regional background evaluation,~~ a TI waiver ~~or upward adjustment of the cleanup levels under the SMS~~~~the SMS compliance mechanism~~ is not justifiable~~selected~~ at this time.

~~The rest of this appendix provides additional detail regarding establishing SCO (Section 2) and CSL (Section 3), possibilities for upwardly adjusting cleanup levels (Section 4), and implementation of an SRZ (Section 5). Section 6 provides a summary of the methods to comply with the SMS ARAR.~~

2 SEDIMENT CLEANUP OBJECTIVES

The SMS outline procedures for establishing the lower bound for cleanup levels, called the SCO. Multiple exposure pathways, background concentrations, and PQLs are all considered when determining the SCO, as follows:

> *WAC 173-204-560 (3) Sediment cleanup objectives. The sediment cleanup objective for a contaminant shall be established as the highest of the following levels:*
>
> *(a) The lowest of the following risk-based levels:*
>
> *(i) The concentration of the contaminant based on protection of human health as specified in WAC 173-204-561(2);*
>
> *(ii) The concentration or level of biological effects of the contaminant based on benthic toxicity as specified in WAC 173-204-562 or 173-204-563, as applicable;*
>
> *(iii) The concentration or level of biological effects of the contaminant estimated to result in no adverse effects to higher trophic level species as specified in WAC 173-204-564; and*
>
> *(iv) Requirements in other applicable laws;*
>
> *(b) Natural background; and*
>
> *(c) Practical quantitation limit.*

As summarized in Tables 4-~~4~~3 and 4-~~5~~4 of the FS, RAOs ~~were~~ established under CERCLA for this FS are consistent with the SMS ~~to be consistent with WAC regulations~~:

- Risk-based threshold concentrations (RBTCs) associated with RAOs 1 and 2 were established in a manner ~~to be~~ consistent with WAC 173-204-560(3)(a)(i)
- RBTCs associated with RAO 3 were established in a manner ~~to be~~ consistent with WAC 173-204-560(3)(a)(ii)
- RBTCs associated with RAO 4 were established in a manner ~~to be~~ consistent with WAC 173-204-560(3)(a)(iii)
- ~~Natural background concentrations were established in a manner to be consistent with WAC 173-340-709~~
- ~~PQLs were established to be consistent with WAC 173-204-505(14)~~

~~Based on WAC 173-204-560(3) and values from the Washington State Department of Ecology (Ecology) Sediment Cleanup User's Manual (SCUM) II (Ecology 2017), the SCO would be established based on natural background for total PCBs (3.5 micrograms per kilogram [µg/kg] dry weight [dw]) and the PQL for dioxins/furans (5 nanograms [ng] toxic equivalent [TEQ]/kg dw), because these are the highest of the three SCO levels for these compounds. The arsenic SCO is also established at natural background, but the Ecology-determined natural background concentration of 11 milligrams per kilogram (mg/kg) is achievable based on best-estimate FS model results and, therefore, the establishment of a CSL value is not required. As discussed in Section 4 of the main body of the FS, EPA has prescribed other methods for determining natural background concentrations for establishing PRGs in compliance with CERCLA (e.g., see FS Table 4-2).~~

3 CLEANUP SCREENING LEVELS

The SMS outline similar procedures for establishing the upper bound for cleanup levels, called the CSL:

WAC 173-204-560 (4) Cleanup screening levels. The cleanup screening level for a contaminant shall be established as the highest of the following levels:

(a) The lowest of the following risk-based levels:

(i) The concentration of the contaminant based on protection of human health as specified in WAC 173-204-561(3);

(ii) The concentration or level of biological effects of the contaminant based on benthic toxicity as specified in WAC 173-204-562 or 173-204-563, as applicable;

(iii) The concentration or level of biological effects of the contaminant estimated to result in no adverse effects to higher trophic level species as specified in WAC 173-204-564; and

(iv) Requirements in other applicable laws;

(b) Regional background as defined in subsection (5) of this section; and

(c) Practical quantitation limit.

RBTCs associated with the CSL (excess cancer risk of 10^{-5} or hazard quotient of 1) are presented in FS Table 3-13 and are well below the SCOs for total PCBs and dioxins/furans.

The SMS defines regional background as follows:

WAC 173-204-505(16)

Regional background means the concentration of a contaminant within a department-defined geographic area that is primarily attributable to diffuse nonpoint sources, such as atmospheric deposition or storm water, not attributable to a specific source or release. See WAC 173-204-560(5) for the procedures and requirements for establishing regional background.

However, because ~~the State has not developed an~~ EPA-approved regional background concentrations have not been developed for the East Waterway area, regional background was not considered in the development of the PRGs for the EW. ~~The CSL for total PCBs and dioxins/furans may be based on regional background concentrations, once established. However, i~~In the absence of regional background concentrations, and because the risk-based levels are below the SCO, the CSL ~~has~~ was not ~~been~~ established for total PCBs or dioxin/furans.

~~Ecology is currently developing an approach to collect additional information to establish regional background for the Lower Duwamish Waterway (LDW), and has not determined how this will be applied to the EW.~~

4 ADJUSTMENT OF CLEANUP LEVELS

For the EW, the FS has established cleanup levels consistent with the SCOs for each of the COCs. Cleanup levels were based on either RBTCs (cPAHs) or natural background (PCBs, dioxins/furans, and arsenic). For those cleanup levels based on natural background there is the potential for post-remedial concentrations to remain above the cleanup level due to regional influences. ~~Because regional background concentrations have not been determined for the EW and the upper bound for the cleanup level (the CSL) has not been determined, the cleanup levels in the FS are set at the SCO for total PCBs and dioxins/furans.~~ As with CERCLA risk-based determinations, the SMS provides ~~provisions that may be considered if~~for situations when the SCO-based cleanup levels cannot be met. The following sections discuss the site-specific factors that could be considered to justify the adjustment of the cleanup levels from the SCO to the CSL.

~~However, if regional background concentrations are established, then, following the SMS, the cleanup levels~~As indicated in Section 9 ~~-~~of the FS, a cleanup level may~~will~~ be adjusted upward based on the following site-specific factors:

> *WAC 173-204-560(2)(a)*
> *(ii) Upward adjustments. The sediment cleanup level may be adjusted upward from the sediment cleanup objective based on the following site-specific factors:*
>
> > *(A) Whether it is technically possible to achieve the sediment cleanup level at the applicable point of compliance within the site or sediment cleanup unit; and*
> > *(B) Whether meeting the sediment cleanup level will have a net adverse environmental impact on the aquatic environment, taking into account the short- and long-term positive effects on natural resources, habitat restoration, and habitat enhancement and the short- and long-term adverse impacts on natural resources and habitat caused by cleanup actions*

~~The following sections discuss the site-specific factors considered to adjust the cleanup levels from the SCO.~~

~~4.1 Technical Possibility~~

~~The technical possibility is defined in SMS as follows:~~

> ~~*WAC 173-204-505(23)*~~
> ~~*"Technically possible" means capable of being designed, constructed and implemented in a reliable and effective manner, regardless of cost.*~~

~~Ecology guidance, provided in the SCUM II (Ecology 2017), further clarifies WAC 173-204-560(2)(a)(ii)(A) that adjustment of the cleanup level upward should be based on "whether it is technically possible to achieve *and maintain* the cleanup level at the applicable point of compliance." [emphasis added]~~

~~This section first estimates the lowest technically possible concentrations that could be achieved in the EW immediately following construction for a hypothetical maximum remediation scenario. It also evaluates what is technically possible to maintain in the long term following construction. The combination of these two evaluations is used to evaluate technical possibility. This analysis is developed for FS purposes only; technical possibility will be determined based on empirical long-term monitoring data for the selected alternative to comply with SMS.~~

~~*4.1.1 Technical Possibility of Maximum Remediation Scenario*~~

~~The EW is a highly urbanized, commercial waterway with actively used marine transportation infrastructure along most of the shoreline area that limit the remedial activities that can occur. For example, full removal of all contaminated sediment near structures is not possible because full removal would affect structural stability. As a result, some amount of undisturbed contaminated sediment will remain in surface sediments near structures following remediation.~~

~~This section describes a design-level analysis on a hypothetical site-wide dredging scenario to estimate the lowest concentration that would be technically possible to achieve for total PCBs at the completion of construction. The scenario was developed assuming that all engineered infrastructure such as piers, engineered embankments, keyways, bridges, and the communication cable crossing would remain in place. Removing and reconstructing the~~

~~infrastructure associated with the EW would require massive modifications (e.g., reconstructing the West Seattle Bridge, temporarily closing important Coast Guard and Port of Seattle terminals, etc.) that would result in excessive disturbance to essential public and private infrastructure. Moreover, this scenario assumed that remediation would be performed by dredging everywhere possible and included residuals management re-dredging passes where practicable to further lower concentrations. Dredging was assumed to be followed by residuals management cover (RMC) in most locations, and was assumed to be followed by in situ treatment with activated carbon in underpier and keyway areas where RMC material could not be placed due to stability concerns and navigation depth requirements. Note that this hypothetical scenario was developed for this analysis only and does not represent an alternative in the FS. Also note that this analysis estimates concentrations at a single point in time (immediately after construction)—ignoring ongoing mixing, propwash, and incoming sedimentation—and is therefore biased low compared to what can be achieved in the long term (Section 4.1.2).~~

~~To support this analysis, the EW was divided into six areas based on the physical constraints of each (Table 1, Figure 1), and spatially-weighted average concentrations (SWACs) immediately following construction were calculated for each as summarized in the following paragraphs.~~

~~Area 1~~

~~The first area consists of most of the open-water areas of the waterway (114 acres), and has the fewest structural limitations affecting remediation. In these areas, the assumed remediation scenario was dredging the waterway to the deepest extent of contaminated sediment, followed by two residuals management re-dredging passes (average of 2 feet removal for each), followed by RMC placement. The resulting concentration immediately following construction in surface sediment (top 10 centimeters [cm]) was estimated to be 10 μg/kg dw for total PCBs for this area, based on the dredging residuals calculation methodology presented in FS Appendix B, Part 3A.~~

~~Area 2~~

~~The second area includes 15 acres of underpier sediments that have limited access and are present on top of slopes comprised of large riprap (see Figure 2). Remediation in these areas~~

~~is challenging due to access limitations and the presence of hard riprap surfaces and rock interstices. These areas were assumed to be dredged by diver-assisted hydraulic dredging, followed by a thin placement of in situ treatment material to reduce bioavailability of the remaining sediment. The resulting post-construction concentration was estimated to be 290 µg/kg dw for total PCBs. This assumed that an average of 10 cm (3.9 inches) of sediments would remain in place following remediation due to the difficulty of full removal on riprap slopes and within rock interstices, followed by the mixing of 7.6 cm (3 inches) of in situ treatment material (see residuals calculations presented in FS Appendix B, Part 3A). In situ treatment material was also assumed to reduce the bioavailability of hydrophobic organic compounds such as PCBs by 70%, resulting in an estimated effective bioavailable underpier average concentration estimated on a dry-weight basis of 153 µg/kg[3]. Note that in situ treatment is a less proven technology than the others presented in this evaluation and, therefore, in situ treatment is used only in areas where other, more-proven technologies are not feasible or unlikely to be effective, such as under the piers (see Section 7.2.7.1 and 7.8 of the FS). Reduction in bioavailability is approximated from available evidence from bench-scale studies and field demonstrations, and is subject to uncertainty.~~

~~Area 3~~

~~The third area includes 7 acres of keyways that are at the base of the underpier slopes (see Figures 1 and 2). These are rock structures keyed into the toe of the riprap slopes to maintain the stability of the slopes above. The tops of the keyways are situated at the navigation depth of approximately -51 feet mean lower low water, therefore limiting the amount of removal and the amount of clean fill placement that can be performed in these areas. Similar to the underpier areas, these areas were assumed to be dredged to the maximum extent possible without removing riprap, followed by a thin placement of in situ treatment material to reduce bioavailability. For this analysis, dredging was assumed to be performed by standard mechanical means. The resulting post-construction concentration was estimated to be 364 µg/kg dw for total PCBs based on an average of 10 cm (3.9 inches) of sediment remaining following dredging, with a 7.6-cm (3-inch) layer of clean in situ treatment material being~~

~~[3] Note the dry-weight concentration is intended to estimate bioavailability reduction to support calculation of a site-wide SWAC that considers the benefits of the application of in situ treatment material, but this concentration is not what would be measured on a dry-weight basis following construction.~~

~~placed following dredging. The effective bioavailable average concentration in keyways (using a 70% reduction in dry weight concentrations) was estimated to be 192 µg/kg. Note that the placement of in situ treatment material in keyways presented for this evaluation is hypothetical to support this evaluation; however, some keyway areas are already at the required navigation elevation and placement would not be possible in some areas due to navigation requirements. In addition, long-term effectiveness and stability of placement near active berthing areas is highly uncertain because of propeller wash (propwash), but was assumed to be stable for the purpose of this analysis.~~

~~Area 4~~

~~The fourth area includes 18 acres of structural slope and offset areas where dredge depths will be limited by the geotechnical stability of adjacent slopes (see Figures 1 and 2). In these areas, some contaminated sediment will be left behind; however, these elevation constraints are assumed to still allow the placement of a full RMC layer (i.e., average 9-inch-thick sand layer). The concentration immediately following completion of construction was estimated to be 35 µg/kg dw for total PCBs based on the dredging residuals methodology presented in Appendix B, Part 3A, of the FS.~~

~~Area 5~~

~~The fifth area includes 2.4 acres under the West Seattle Bridge and the bridge at the head of Slip 27 that have access restrictions (Figure 1). In these areas, removal is limited by geotechnical and structural considerations required to maintain stability of bridge columns. However, these areas are not limited in the amount of clean cover that could be placed following dredging. In addition, these areas experience little to no sediment disturbance from propwash. The resulting post-construction concentration was estimated to be 10 µg/kg dw for total PCBs through limited removal and RMC placement.~~

~~Area 6~~

~~The sixth area includes 1.8 acres under the three low bridges in the Sill Reach (Figure 1). These areas are characterized by extreme access limitations and widespread debris. Diver-assisted hydraulic dredging would be ineffective in these areas due to the presence of debris. Therefore, enhanced natural recovery (ENR) was assumed in these areas, with a post-~~

~~construction concentration of 8 µg/kg dw, as a result of some dredging residuals depositing from adjacent areas consistent with the conceptual site model of sediment transport in the EW.~~

~~This analysis demonstrated that it is not technically possible to achieve the natural background-based SCO for total PCBs. Considering all of these areas together, the site-wide SWAC immediately following construction was estimated to be 57 µg/kg dw for total PCBs, with an effective bioavailable concentration of 34 µg/kg. Note that this post-construction SWAC is the theoretical limit of technical possibility. As discussed above, this hypothetical SWAC assumes that construction would be completed uniformly across the site, at a single point in time (e.g., instantaneously), therefore, this analysis does not consider the sediment mixing and exchange or ongoing sediment deposition that would occur over the timeframe required to conduct this cleanup. Moreover, this hypothetical scenario would have a construction timeframe of more than 15 years, during which time sediments would be mixing due to vessel propwash. Accordingly, the above site-wide post-construction SWAC represents an idealized condition that cannot realistically be achieved during remedy implementation.~~

~~*4.1.2 Maintenance in the Long Term*~~

~~This section describes four considerations for whether it would be technically possible to maintain the natural-background based SCOs for total PCBs and dioxin/furan in the long term, considering the lowest technically possible achievable concentration estimated in Section 4.1.1. The four considerations are as follows:~~

1. ~~Predicted increase in the SWAC following sediment mixing and exchange between underpier and open-water sediment~~
2. ~~Predicted future average concentrations in particulate matter entering the EW~~
3. ~~Measured concentrations present in surface sediment at remediated sites proximal to the EW~~
4. ~~Measured surface sediment concentrations in Elliott Bay~~

~~The first line of evidence is the box model site-wide SWAC predictions. Following construction, box model predictions of the site-wide SWAC for each of the remediation alternatives except no action increase in the short-term (e.g., year 5 following construction)~~

~~as a result of sediment mixing and exchange between open-water and underpier sediments (see FS Appendix J). The box model predicts that concentrations will then gradually reduce toward the net incoming sediment concentrations over time, which are above natural background-based cleanup levels and lowest technically possible achievable concentration for total PCBs and dioxins/furans (see next line of evidence).~~

~~The second line of evidence is the concentration of incoming sediments. Table 2 provides the estimated average sediment input concentrations for the EW based on incoming solids from both upstream (including Green River and LDW) and EW lateral inputs. These concentrations were calculated using a weighted average of chemical concentrations based on inputs entering the EW from the Green/Duwamish River, resuspended LDW bedded sediment, and lateral inputs from both the LDW and EW (see FS Table 5-5). Average input concentrations do not incorporate concentrations that may come from the EW bed, including the dredge residuals that will be present following construction, and sediments in unremediated areas. Average input concentrations were developed for the base case (best estimate), low bounding, and high bounding runs, adjusted to account for additional source control for lateral inputs (i.e., combined sewer overflow [CSO] and stormwater inputs) managed by source control programs (e.g., National Pollutant Discharge Elimination System [NPDES]). For total PCBs, the average input concentrations ranged from 8 to 85 µg/kg dw, and for dioxin/furans the average input concentrations ranged from 2 to 8 ng TEQ/kg dw. The base case (best estimates) values for both total PCBs (45 µg/kg dw) and dioxins/furans (6 ng TEQ/kg dw) are well above the SCO concentrations for total PCBs (3 µg/kg dw), and marginally above the SCO for dioxins/furans (5 ng TEQ/kg dw).~~

~~The third line of evidence is the post-remediation surface sediment concentrations of four cleanup sites in relatively close proximity to the EW, which were selected as representative of the post-remediation concentrations that could be expected to be achieved in the long term. Table 2 summarizes the most recent available post-remediation monitoring data for Pier 53-54, Lockheed Shipyard, Todd Shipyards, and Duwamish Diagonal, as well as the form of remediation (dredging, capping, or ENR) used at each site. The surface sediment data range from 5 to 10 years post-remediation and represent the surface sediment concentrations that can be expected following dredging, capping, or ENR, as well as the influence of ongoing sedimentation from diffuse urban inputs. Mean concentrations from the above four~~

~~datasets suggest that post-remediation concentrations in the EW could range from approximately 32 to 133 µg/kg dw for total PCBs, and be approximately 5 ng TEQ/kg dw for dioxin/furans (data from Duwamish/Diagonal cap only), depending on the dataset considered. These concentrations exceed the natural background levels for total PCBs and dioxins/furans. The resultant ranges of concentrations from all four of the datasets suggest that it is not technically possible to maintain the SCO for total PCBs (3.5 µg/kg dw) and may or may not be possible to maintain the SCO for dioxins/furans (5 ng TEQ/kg dw) in the long term in this region of Puget Sound, including the EW.~~

~~The fourth line of evidence is surface sediment concentrations from Elliott Bay. These data represent ambient concentrations in Elliott Bay, which provides an estimate of deposited sediment from diffuse urban inputs that may influence expected long-term concentrations. As shown in Table 2, inner Elliott Bay[4] samples had a mean total PCBs concentration of 153 µg/kg dw (2007 data), and the mean dioxins/furans concentration was 20 ng TEQ/kg dw (2007 data). Concentrations are higher when 90th percentile values are considered (274 µg/kg dw for total PCBs based on 2007 data). In outer Elliott Bay, mean total PCBs concentrations range from 28 µg/kg dw (2007 data) to 32 µg/kg dw (1991 to 2004 data), and the mean dioxins/furans concentration was 2 ng TEQ/kg dw (2007 data) (see Table 2). Concentrations are higher when 90th percentile values are considered (e.g., 53 µg/kg dw for total PCBs based on 2007 data). Post-remediation concentrations of total PCBs and dioxins/furans in sediment in the EW would be higher than these values because of its closer proximity to diffuse urban inputs, which are more represented by data from inner Elliott Bay.~~

~~In summary, all the lines of evidence to determine concentrations that can be achieved in the long term in the EW indicate that the SCO will not be achieved or maintained. For total PCBs, the average concentrations are well above the SCO of 3.5 µg/kg dw, and range of achievable concentrations for all lines of evidence is 9 to 153 µg/kg dw. For dioxins/furans, the average concentrations are well above the SCO of 5.0 ng TEQ/kg dw, and range of~~

[4] ~~Inner Elliott Bay samples are generally defined as samples east of a line from Terminal 91 directly south to West Seattle. Outer Elliott Bay includes the samples west of the line. See the depiction in Appendix J, Figure J-3, of the LDW FS (AECOM 2012).~~

~~achievable concentrations for all lines of evidence is 1.7 to 20 ng TEQ/kg dw. Regional background concentrations, when determined, are expected to fall within this range.~~

~~4.2 Net Adverse Environmental Impact~~

~~The second factor in determining an upward adjustment of the SCO-based cleanup level is the determination of net adverse impact on the aquatic environment, which takes into account "the short- and long-term positive effects on natural resources, habitat restoration, and habitat enhancement and the short- and long-term adverse impacts on natural resources and habitat caused by cleanup actions" (WAC 173-204-560(2)(a)(ii)(B)).~~

~~SMS cleanup levels for total PCBs and dioxin/furans that are not adjusted significantly upward from the SCO could only be met and reliably maintained with additional dredging over larger areas and at greater depths, and repeated capping and redredging of the same areas as concentrations rise due to diffuse source inputs over time. This approach would result in very large adverse impacts on the aquatic environment (natural resources and habitat) from construction without producing any countervailing long-term environmental benefits from the additional cleanup measures (i.e., risk reduction). Repeated rounds of dredging and/or capping would result in major additional construction-related adverse impacts to the benthic community, due to disruption of the established biological active zone, and to fish tissue contaminant levels, due to releases of contaminated material during dredging, resulting in higher fish exposures. In addition, these adverse impacts would occur over a significantly longer period of time. Even with ongoing efforts of this type, evidence presented in Section 4.1 of this appendix suggests that the SCOs for total PCBs and dioxin/furans would still not be achieved. As such, the continued cleanup activities in an attempt to reach concentrations closer to the SCO would result in significant adverse impacts to the environment without commensurate benefits to the benthic community or reductions in tissue concentrations that would lower human health risks. Ultimately, the EW system will equilibrate to incoming sediment concentrations that are higher than the SCO and similar to concentrations resulting from less disruptive cleanup activities associated with higher cleanup levels (e.g., CSL).~~

~~In comparison, SMS cleanup levels based on the CSL for total PCBs and dioxin/furans (i.e., regional background, once established) would result in slightly smaller adverse impacts on the aquatic environment from construction because the cleanup technologies needed to meet the cleanup levels would be less intrusive to benthic communities in some areas (less dredging or capping), and the need for additional contingency actions would be greatly reduced or eliminated. A cleanup level at or close to the regional background for total PCBs and dioxin/furans, once established, would reflect the concentrations of those contaminants in incoming sediment over the long term, thereby avoiding unnecessary adverse impacts on the aquatic environment from construction and ultimately resulting in similar or improved long-term environmental benefits from cleanup (i.e., risk-reduction). Therefore, sediment cleanup levels based on SCO will result in net adverse impacts, which would not occur with cleanup levels that are adjusted upward to the CSL based on regional background.~~

~~4.3 Summary and Conclusion~~

If, after evaluating long-term monitoring trends, EPA doesn't expect the remedy to comply with the natural background-based PRGs, c~~C~~ompliance with the SMS ~~will require~~could be accomplished through the adjustment of cleanup levels upward from the SCO to the CSL for total PCBs and dioxins/furans. This adjustment ~~will~~may occur in the future ~~when~~if the CSL (i.e., regional background) is established for these contaminants.

~~For FS purposes, a hypothetical maximum removal scenario was analyzed to approximate lowest technically possible concentrations for total PCBs that could be achieved following construction. This analysis indicated that approximately 57 μg/kg dw could be achieved (34 μg/kg when making adjustments for bioavailability) when considering limitations to remediating near structures to achieve very low total PCBs concentrations.~~

~~Multiple lines of evidence were analyzed to approximate values that could be achieved in the long term. For total PCBs, the average concentrations are well above the SCO of 3.5 μg/kg dw, and range of achievable concentrations for all lines of evidence is 9 to 153 μg/kg dw. For dioxins/furans, the average concentrations are above the SCO of 5.0 ng TEQ/kg dw, and range of achievable concentrations for all lines of evidence is 1.7 to 20 ng TEQ/kg dw. As discussed in Section 4, the cleanup level may not be adjusted above the CSL (i.e., regional background values, once established).~~

~~Finally, the net adverse environmental impact for setting the cleanup level at the SCO was qualitatively discussed, indicating that the cleanup levels need to be adjusted upward to the CSL, when established, to avoid environmental disturbances that results in no environmental benefit.~~

~~5 SEDIMENT RECOVERY ZONE~~

~~Under SMS, If a restoration timeframe is expected to beof longer than 10 years (i.e., cleanup levels not achieved within 10 years), SMS allows for the would result in the designation of an SRZ (WAC 173-204-570(5)(b)). SMS define the SRZ as the following:~~

> ~~*"Sediment recovery zone" means an area authorized by the department within a site or sediment cleanup unit where the department has determined the cleanup action cannot achieve the applicable sediment cleanup standards within ten years after completion of construction of the active components of the cleanup action.*~~

~~The SRZ is an administrative tool used to track a cleanup area that remains above cleanup levels and perform additional cleanup or source control actions as necessary. The requirements of the SRZ are listed in WAC 173-204-590(2), are very similar to the CERCLA requirements of the selected remedy, and would be substantively met through CERCLA components of the remedy (e.g., the long-term monitoring and 5-year review framework, and the alternative analysis, comparison, and selection process).~~

~~The key components of the SRZ approach, if used, are the following:~~

- ~~The SRZ would be designated side-wide for relevant human health risk drivers 10 years following construction.~~
- ~~The Harbor Island Superfund Site 5-year reviews and site-wide monitoring program would provide the periodic review process for adjusting, eliminating, or renewing the SRZ consistent with SMS.~~
- ~~The SRZ would be used in concert with active cleanup and source control measures for the selected alternative and would allow for additional time to cleanup. It , and would not replace cleanup actions. The contaminant concentrations within the SRZ will be as close as practicable to the cleanup level, based on the CERCLA comparison of alternatives under the nine criteria in the FS.~~

~~For the EW, post-construction site-wide monitoring data would be used to evaluate progress toward meeting the cleanup levels. This information could also be used to support establishment or evaluation of regional background concentrations and potential modification of the SRZ and closure of the site.~~

~~*If monitoring data shows cleanup standards cannot be met, the following options are available for Ecology to consider:*~~

1. ~~*If noncompliance is due to PLP sources not being controlled, additional source control may be necessary.*~~
2. ~~*If noncompliance is due to contribution from other sources that are not under the responsibility or authority of the PLP, closure of the SRZ may be appropriate or adjustment of the cleanup level may be appropriate. For example:*~~
   a. ~~*Ecology may consider whether the cleanup level should be adjusted upwards according to the process detailed in Chapter 7, Section 7.2.3. An example of when this may be appropriate is where the cleanup level was established below regional background, but Ecology has since established or approved regional background for the geographic area where the site is located. In this case, Ecology may determine that regional background represents the concentration in sediment that is technically possible to maintain, due to ongoing sources that are not under the authority or responsibility of the PLP. Therefore, Ecology could allow upwards adjustment of the sediment cleanup level to the CSL if regional background has been established as the CSL.*~~
   b. ~~*If the cleanup levels are based on background (regional or natural), Ecology will consider whether background concentrations have increased and the cleanup level should be adjusted upwards.*~~

~~(Ecology 2017, Section 14.2.6)~~

~~6~~5 CONCLUSIONS

The PRGs in the EW FS have been developed under CERCLA to be consistent with SMS (WAC 173-204-560). The selected alternative will meet the SMS ARAR over time by achieving the SCO, ~~or~~ by achieving the cleanup level after the establishment of a CSL and upward adjustment of the cleanup level, or by establishment of a TI waiver. If cleanup levels are not achieved within 10 years following construction, then ~~the substantive requirements of an SRZ will be met through the~~additional time for achieving the cleanup levels may be warranted under CERCLA if determined to be appropriate by EPA. ~~5-year review process.~~

Because it is not known whether, or to what extent, the SMS ARARs for various COCs will be achieved in the long term, or the timing of a potential regional background evaluation, a TI waiver or upward adjustment of the cleanup levels under the SMS~~the SMS compliance mechanism~~ is not justifiable~~selected~~ at this time. The method used to comply with the SMS ARAR will depend primarily on the timing of regional background evaluations for the EW and measured site performance following construction.

~~EPA may also issue a TI waiver at some point in the future if EPA determines that SMS-based cleanup levels cannot be practicably achieved within the EW based on long-term monitoring data and trends. This would be conducted either as part of a ROD Amendment or an ESD.~~

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~~TABLES~~

FIGURES

EXHIBIT 4

APPENDIX A – SUPPLEMENTAL INFORMATION FOR SELECTION OF PRGS

EAST WATERWAY OPERABLE UNIT FEASIBILITY STUDY

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APPENDIX A TABLE OF CONTENTS

PART 1: COMPLIANCE WITH SEDIMENT MANAGEMENT STANDARDS

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1 INTRODUCTION

The Feasibility Study (FS) for the East Waterway (EW) Operable Unit (OU) has been developed under the regulatory framework of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Consistent with CERCLA requirements, the selected alternative must substantively comply with applicable or relevant and appropriate requirements (ARARs), which include the Washington State Sediment Management Standards (SMS). The SMS are the Washington State standards for remediating sediments under the Model Toxics Control Act (MTCA). This appendix describes the methods and procedures for establishing cleanup levels under the SMS, and also discusses how the selected EW alternative will comply with SMS requirements.

The preliminary remediation goals (PRGs) presented in Section 4 of the FS were developed to comply with the SMS determination of cleanup levels[1] under Washington Administrative Code (WAC) 173-204-560. The SMS cleanup level determination is performed by determining the sediment cleanup objectives (SCO; discussed in Section 2 of this appendix) and the cleanup screening levels (CSL; discussed in Section 3 of this appendix). The cleanup levels are initially set at the SCO. If the SCO is not technically possible to attain, or would result in net adverse environmental impacts, then the cleanup level can be adjusted up to the CSL. For several contaminants of concern (COCs) in the FS, the SCO has been established at natural background or practical quantitation levels (PQLs), but the CSL has not been established because regional background has not been determined for the EW area. In the absence of regional background values, cleanup levels (i.e., PRGs) for these COCs are based on the SCO in the EW FS. For some of these COCs, the SCO is not technically possible to achieve. As described in Sections 2, 3, and 4, total polychlorinated biphenyls (PCBs) and dioxins/furans currently have cleanup levels based on unattainable natural background or PQL concentrations based on the best-estimate predictions of sediment concentrations in the FS (e.g., see FS Section 9).[2]

[1] The SMS term "cleanup level" is analogous to the CERCLA term "PRG" used in the main text of the FS. This appendix uses the term "cleanup level" for consistency with the SMS.

[2] Note that none of the alternatives is predicted to achieve the SCO for these chemicals; therefore, this appendix applies equally to any of the alternatives, if selected.

Based on preliminary evaluations, the EW OU cleanup is expected to comply with MTCA/SMS for protectiveness of human health for direct contact (remedial action objective [RAO] 2), protection of the benthic community (RAO 3), and protection of higher trophic level organisms (RAO 4) by achieving the PRGs for these RAOs. Following source control and remediation efforts, surface sediments in the EW OU are not currently predicted to attain all natural background- or PQL-based PRGs for protection of human health for seafood consumption (RAO 1), due to the ongoing contribution of elevated concentrations from diffuse, nonpoint sources of contamination that contribute to regional background concentrations. However, achieving the MTCA/SMS ARARs may occur in one of two ways:

- Post-remedy monitoring may demonstrate sediment concentrations lower than currently predicted, and PRGs identified in this FS may be attained for certain chemicals in a reasonable restoration timeframe. If necessary, the restoration timeframe needed to meet the PRGs could be extended beyond 10 years consistent with the substantive requirements of a Sediment Recovery Zone (SRZ) as defined by SMS (see Section 5 of this appendix).
- Sediment cleanup levels (SCLs) may be adjusted upward once regional background levels are established for the geographic area of the EW (see Section 4 of this appendix). Considering that a regional background value has not yet been determined for the EW, such adjustments could occur in the Record of Decision (ROD) (before remediation) or subsequently as part of a ROD amendment or Explanation of Significant Differences (ESD) (during or after remediation). Consistent with the bullet above, the restoration timeframe needed to meet the SCLs could be extended beyond 10 years consistent with the substantive requirements of an SRZ as defined by SMS.

In addition, following remediation and long-term monitoring, if the U.S. Environmental Protection Agency (EPA) determines that no additional practicable actions can be implemented under CERCLA to meet certain MTCA/SMS ARARs, EPA may issue a ROD Amendment or ESD providing the basis for a technical impracticability (TI) waiver for specified MTCA/SMS ARARs under Section 121(d)(4)(C) of CERCLA.

Because it is not known whether, or to what extent, the SMS ARARs for total PCBs and dioxin/furans will be achieved in the long term, or the timing of a potential regional background evaluation, the SMS compliance mechanism is not selected at this time.

The rest of this appendix provides additional detail regarding establishing SCO (Section 2) and CSL (Section 3), upwardly adjusting cleanup levels (Section 4), and implementation of an SRZ (Section 5). Section 6 provides a summary of the methods to comply with the SMS ARAR.

2 SEDIMENT CLEANUP OBJECTIVES

The SMS outline procedures for establishing the lower bound for cleanup levels, called the SCO. Multiple exposure pathways, background concentrations, and PQLs are all considered when determining the SCO, as follows:

> *WAC 173-204-560 (3) Sediment cleanup objectives. The sediment cleanup objective for a contaminant shall be established as the highest of the following levels:*
>
> *(a) The lowest of the following risk-based levels:*
>
> *(i) The concentration of the contaminant based on protection of human health as specified in WAC 173-204-561(2);*
>
> *(ii) The concentration or level of biological effects of the contaminant based on benthic toxicity as specified in WAC 173-204-562 or 173-204-563, as applicable;*
>
> *(iii) The concentration or level of biological effects of the contaminant estimated to result in no adverse effects to higher trophic level species as specified in WAC 173-204-564; and*
>
> *(iv) Requirements in other applicable laws;*
>
> *(b) Natural background; and*
>
> *(c) Practical quantitation limit.*

As summarized in Tables 4-4 and 4-5 of the FS, RAOs were established to be consistent with WAC regulations:

- Risk-based threshold concentrations (RBTCs) associated with RAOs 1 and 2 were established to be consistent with WAC 173-204-560(3)(a)(i)
- RBTCs associated with RAO 3 were established to be consistent with WAC 173-204-560(3)(a)(ii)
- RBTCs associated with RAO 4 were established to be consistent with WAC 173-204-560(3)(a)(iii)
- Natural background concentrations were established to be consistent with WAC 173-340-709
- PQLs were established to be consistent with WAC 173-204-505(14)

Based on WAC 173-204-560(3) and values from the Washington State Department of Ecology (Ecology) Sediment Cleanup User's Manual (SCUM) II (Ecology 2017), the SCO would be established based on natural background for total PCBs (3.5 micrograms per kilogram [µg/kg] dry weight [dw]) and the PQL for dioxins/furans (5 nanograms [ng] toxic equivalent [TEQ]/kg dw), because these are the highest of the three SCO levels for these compounds. The arsenic SCO is also established at natural background, but the Ecology-determined natural background concentration of 11 milligrams per kilogram (mg/kg) is achievable based on best-estimate FS model results and, therefore, the establishment of a CSL value is not required. As discussed in Section 4 of the main body of the FS, EPA has prescribed other methods for determining natural background concentrations for establishing PRGs in compliance with CERCLA (e.g., see FS Table 4-2).

3 CLEANUP SCREENING LEVELS

The SMS outline similar procedures for establishing the upper bound for cleanup levels, called the CSL:

> *WAC 173-204-560 (4) Cleanup screening levels. The cleanup screening level for a contaminant shall be established as the highest of the following levels:*
>
> *(a) The lowest of the following risk-based levels:*
>
> *(i) The concentration of the contaminant based on protection of human health as specified in WAC 173-204-561(3);*
>
> *(ii) The concentration or level of biological effects of the contaminant based on benthic toxicity as specified in WAC 173-204-562 or 173-204-563, as applicable;*
>
> *(iii) The concentration or level of biological effects of the contaminant estimated to result in no adverse effects to higher trophic level species as specified in WAC 173-204-564; and*
>
> *(iv) Requirements in other applicable laws;*
>
> *(b) Regional background as defined in subsection (5) of this section; and*
>
> *(c) Practical quantitation limit.*

RBTCs associated with the CSL (excess cancer risk of 10^{-5} or hazard quotient of 1) are presented in FS Table 3-13 and are well below the SCOs for total PCBs and dioxins/furans. The SMS define regional background as follows:

> *WAC 173-204-505(16)*
>
> *Regional background means the concentration of a contaminant within a department-defined geographic area that is primarily attributable to diffuse nonpoint sources, such as atmospheric deposition or storm water, not attributable to a specific source or release. See WAC 173-204-560(5) for the procedures and requirements for establishing regional background.*

The CSL for total PCBs and dioxins/furans may be based on regional background concentrations, once established. However, in the absence of regional background concentrations, and because the risk-based levels are below the SCO, the CSL has not been established for total PCBs or dioxin/furans.

Ecology is currently developing an approach to collect additional information to establish regional background for the Lower Duwamish Waterway (LDW), and has not determined how this will be applied to the EW.

4 ADJUSTMENT OF CLEANUP LEVELS

Because regional background concentrations have not been determined for the EW and the upper bound for the cleanup level (the CSL) has not been determined, the cleanup levels in the FS are set at the SCO for total PCBs and dioxins/furans. However, if regional background concentrations are established, then, following the SMS, the cleanup levels will be adjusted upward based on the following site-specific factors:

> *WAC 173-204-560(2)(a)*
> *(ii) Upward adjustments. The sediment cleanup level may be adjusted upward from the sediment cleanup objective based on the following site-specific factors:*
>> *(A) Whether it is technically possible to achieve the sediment cleanup level at the applicable point of compliance within the site or sediment cleanup unit; and*
>> *(B) Whether meeting the sediment cleanup level will have a net adverse environmental impact on the aquatic environment, taking into account the short- and long-term positive effects on natural resources, habitat restoration, and habitat enhancement and the short- and long-term adverse impacts on natural resources and habitat caused by cleanup actions*

The following sections discuss the site-specific factors considered to adjust the cleanup levels from the SCO.

4.1 Technical Possibility

The technical possibility is defined in SMS as follows:

> *WAC 173-204-505(23)*
> *"Technically possible" means capable of being designed, constructed and implemented in a reliable and effective manner, regardless of cost.*

Ecology guidance, provided in the SCUM II (Ecology 2017), further clarifies WAC 173-204-560(2)(a)(ii)(A) that adjustment of the cleanup level upward should be based on "whether it is technically possible to achieve *and maintain* the cleanup level at the applicable point of compliance." [emphasis added]

This section first estimates the lowest technically possible concentrations that could be achieved in the EW immediately following construction for a hypothetical maximum remediation scenario. It also evaluates what is technically possible to maintain in the long term following construction. The combination of these two evaluations is used to evaluate technical possibility. This analysis is developed for FS purposes only; technical possibility will be determined based on empirical long-term monitoring data for the selected alternative to comply with SMS.

4.1.1 Technical Possibility of Maximum Remediation Scenario

The EW is a highly urbanized, commercial waterway with actively used marine transportation infrastructure along most of the shoreline area that limit the remedial activities that can occur. For example, full removal of all contaminated sediment near structures is not possible because full removal would affect structural stability. As a result, some amount of undisturbed contaminated sediment will remain in surface sediments near structures following remediation.

This section describes a design-level analysis on a hypothetical site-wide dredging scenario to estimate the lowest concentration that would be technically possible to achieve for total PCBs at the completion of construction. The scenario was developed assuming that all engineered infrastructure such as piers, engineered embankments, keyways, bridges, and the communication cable crossing would remain in place. Removing and reconstructing the infrastructure associated with the EW would require massive modifications (e.g., reconstructing the West Seattle Bridge, temporarily closing important Coast Guard and Port of Seattle terminals, etc.) that would result in excessive disturbance to essential public and private infrastructure. Moreover, this scenario assumed that remediation would be performed by dredging everywhere possible and included residuals management re-dredging passes where practicable to further lower concentrations. Dredging was assumed to be followed by residuals management cover (RMC) in most locations, and was assumed to be followed by in situ treatment with activated carbon in underpier and keyway areas where RMC material could not be placed due to stability concerns and navigation depth requirements. Note that this hypothetical scenario was developed for this analysis only and does not represent an alternative in the FS. Also note that this analysis estimates concentrations at a single point in time (immediately after construction)—ignoring ongoing mixing, propwash, and incoming sedimentation—and is therefore biased low compared to what can be achieved in the long term (Section 4.1.2).

To support this analysis, the EW was divided into six areas based on the physical constraints of each (Table 1, Figure 1), and spatially-weighted average concentrations (SWACs) immediately following construction were calculated for each as summarized in the following paragraphs.

Area 1

The first area consists of most of the open-water areas of the waterway (114 acres), and has the fewest structural limitations affecting remediation. In these areas, the assumed remediation scenario was dredging the waterway to the deepest extent of contaminated sediment, followed by two residuals management re-dredging passes (average of 2 feet removal for each), followed by RMC placement. The resulting concentration immediately following construction in surface sediment (top 10 centimeters [cm]) was estimated to be 10 µg/kg dw for total PCBs for this area, based on the dredging residuals calculation methodology presented in FS Appendix B, Part 3A.

Area 2

The second area includes 15 acres of underpier sediments that have limited access and are present on top of slopes comprised of large riprap (see Figure 2). Remediation in these areas is challenging due to access limitations and the presence of hard riprap surfaces and rock interstices. These areas were assumed to be dredged by diver-assisted hydraulic dredging, followed by a thin placement of in situ treatment material to reduce bioavailability of the remaining sediment. The resulting post-construction concentration was estimated to be 290 µg/kg dw for total PCBs. This assumed that an average of 10 cm (3.9 inches) of sediments would remain in place following remediation due to the difficulty of full removal on riprap slopes and within rock interstices, followed by the mixing of 7.6 cm (3 inches) of in situ treatment material (see residuals calculations presented in FS Appendix B, Part 3A). In situ treatment material was also assumed to reduce the bioavailability of hydrophobic organic compounds such as PCBs by 70%, resulting in an estimated effective bioavailable underpier average concentration estimated on a dry-weight basis of 153 μg/kg[3]. Note that in situ treatment is a less proven technology than the others presented in this evaluation and, therefore, in situ treatment is used only in areas where other, more-proven technologies are not feasible or unlikely to be effective, such as under the piers (see Section 7.2.7.1 and 7.8 of the FS). Reduction in bioavailability is approximated from available evidence from bench-scale studies and field demonstrations, and is subject to uncertainty.

Area 3

The third area includes 7 acres of keyways that are at the base of the underpier slopes (see Figures 1 and 2). These are rock structures keyed into the toe of the riprap slopes to maintain the stability of the slopes above. The tops of the keyways are situated at the navigation depth of approximately -51 feet mean lower low water, therefore limiting the amount of removal and the amount of clean fill placement that can be performed in these areas. Similar to the underpier areas, these areas were assumed to be dredged to the maximum extent possible without removing riprap, followed by a thin placement of in situ treatment material to reduce bioavailability. For this analysis, dredging was assumed to be performed by standard mechanical means. The resulting post-construction concentration was estimated to be 364 μg/kg dw for total PCBs based on an average of 10 cm (3.9 inches) of sediment remaining following dredging, with a 7.6-cm (3-inch) layer of clean in situ treatment material being placed following dredging. The effective bioavailable average concentration in keyways (using a 70% reduction in dry weight concentrations) was estimated to be 192 μg/kg. Note that the placement of in situ treatment material in keyways presented for this evaluation is hypothetical to support this evaluation; however, some keyway areas are already at the required navigation elevation and placement would not be possible in some areas due to navigation requirements. In addition, long-term effectiveness and stability of placement near active berthing areas is highly uncertain because of propeller wash (propwash), but was assumed to be stable for the purpose of this analysis.

[3] Note the dry-weight concentration is intended to estimate bioavailability reduction to support calculation of a site-wide SWAC that considers the benefits of the application of in situ treatment material, but this concentration is not what would be measured on a dry-weight basis following construction.

Area 4

The fourth area includes 18 acres of structural slope and offset areas where dredge depths will be limited by the geotechnical stability of adjacent slopes (see Figures 1 and 2). In these areas, some contaminated sediment will be left behind; however, these elevation constraints are assumed to still allow the placement of a full RMC layer (i.e., average 9-inch-thick sand layer). The concentration immediately following completion of construction was estimated to be 35 µg/kg dw for total PCBs based on the dredging residuals methodology presented in Appendix B, Part 3A, of the FS.

Area 5

The fifth area includes 2.4 acres under the West Seattle Bridge and the bridge at the head of Slip 27 that have access restrictions (Figure 1). In these areas, removal is limited by geotechnical and structural considerations required to maintain stability of bridge columns. However, these areas are not limited in the amount of clean cover that could be placed following dredging. In addition, these areas experience little to no sediment disturbance from propwash. The resulting post-construction concentration was estimated to be 10 µg/kg dw for total PCBs through limited removal and RMC placement.

Area 6

The sixth area includes 1.8 acres under the three low bridges in the Sill Reach (Figure 1). These areas are characterized by extreme access limitations and widespread debris. Diver-assisted hydraulic dredging would be ineffective in these areas due to the presence of debris. Therefore, enhanced natural recovery (ENR) was assumed in these areas, with a post-construction concentration of 8 µg/kg dw, as a result of some dredging residuals depositing from adjacent areas consistent with the conceptual site model of sediment transport in the EW.

This analysis demonstrated that it is not technically possible to achieve the natural background-based SCO for total PCBs. Considering all of these areas together, the site-wide SWAC immediately following construction was estimated to be 57 µg/kg dw for total PCBs, with an effective bioavailable concentration of 34 µg/kg. Note that this post-construction SWAC is the theoretical limit of technical possibility. As discussed above, this hypothetical SWAC assumes that construction would be completed uniformly across the site, at a single point in time (e.g., instantaneously), therefore, this analysis does not consider the sediment mixing and exchange or ongoing sediment deposition that would occur over the timeframe required to conduct this cleanup. Moreover, this hypothetical scenario would have a construction timeframe of more than 15 years, during which time sediments would be mixing due to vessel propwash. Accordingly, the above site-wide post-construction SWAC represents an idealized condition that cannot realistically be achieved during remedy implementation.

4.1.2 Maintenance in the Long Term

This section describes four considerations for whether it would be technically possible to maintain the natural-background based SCOs for total PCBs and dioxin/furan in the long term, considering the lowest technically possible achievable concentration estimated in Section 4.1.1. The four considerations are as follows:

1. Predicted increase in the SWAC following sediment mixing and exchange between underpier and open-water sediment
2. Predicted future average concentrations in particulate matter entering the EW
3. Measured concentrations present in surface sediment at remediated sites proximal to the EW
4. Measured surface sediment concentrations in Elliott Bay

The first line of evidence is the box model site-wide SWAC predictions. Following construction, box model predictions of the site-wide SWAC for each of the remediation alternatives except no action increase in the short-term (e.g., year 5 following construction) as a result of sediment mixing and exchange between open-water and underpier sediments (see FS Appendix J). The box model predicts that concentrations will then gradually reduce toward the net incoming sediment concentrations over time, which are above natural background-based cleanup levels and lowest technically possible achievable concentration for total PCBs and dioxins/furans (see next line of evidence).

The second line of evidence is the concentration of incoming sediments. Table 2 provides the estimated average sediment input concentrations for the EW based on incoming solids from both upstream (including Green River and LDW) and EW lateral inputs. These concentrations were calculated using a weighted average of chemical concentrations based on inputs entering the EW from the Green/Duwamish River, resuspended LDW bedded sediment, and lateral inputs from both the LDW and EW (see FS Table 5-5). Average input concentrations do not incorporate concentrations that may come from the EW bed, including the dredge residuals that will be present following construction, and sediments in unremediated areas. Average input concentrations were developed for the base case (best estimate), low bounding, and high bounding runs, adjusted to account for additional source control for lateral inputs (i.e., combined sewer overflow [CSO] and stormwater inputs) managed by source control programs (e.g., National Pollutant Discharge Elimination System [NPDES]). For total PCBs, the average input concentrations ranged from 8 to 85 µg/kg dw, and for dioxin/furans the average input concentrations ranged from 2 to 8 ng TEQ/kg dw. The base case (best estimates) values for both total PCBs (45 µg/kg dw) and dioxins/furans (6 ng TEQ/kg dw) are well above the SCO concentrations for total PCBs (3 µg/kg dw), and marginally above the SCO for dioxins/furans (5 ng TEQ/kg dw).

The third line of evidence is the post-remediation surface sediment concentrations of four cleanup sites in relatively close proximity to the EW, which were selected as representative of the post-remediation concentrations that could be expected to be achieved in the long term. Table 2 summarizes the most recent available post-remediation monitoring data for Pier 53-54, Lockheed Shipyard, Todd Shipyards, and Duwamish Diagonal, as well as the form of remediation (dredging, capping, or ENR) used at each site. The surface sediment data range from 5 to 10 years post-remediation and represent the surface sediment concentrations that can be expected following dredging, capping, or ENR, as well as the influence of ongoing sedimentation from diffuse urban inputs. Mean concentrations from the above four datasets suggest that post-remediation concentrations in the EW could range from approximately 32 to 133 µg/kg dw for total PCBs, and be approximately 5 ng TEQ/kg dw for dioxin/furans (data from Duwamish/Diagonal cap only), depending on the dataset considered. These concentrations exceed the natural background levels for total PCBs and dioxins/furans. The resultant ranges of concentrations from all four of the datasets suggest that it is not technically possible to maintain the SCO for total PCBs (3.5 µg/kg dw) and may or may not be possible to maintain the SCO for dioxins/furans (5 ng TEQ/kg dw) in the long term in this region of Puget Sound, including the EW.

The fourth line of evidence is surface sediment concentrations from Elliott Bay. These data represent ambient concentrations in Elliott Bay, which provides an estimate of deposited sediment from diffuse urban inputs that may influence expected long-term concentrations. As shown in Table 2, inner Elliott Bay[4] samples had a mean total PCBs concentration of 153 µg/kg dw (2007 data), and the mean dioxins/furans concentration was 20 ng TEQ/kg dw (2007 data). Concentrations are higher when 90th percentile values are considered (274 µg/kg dw for total PCBs based on 2007 data). In outer Elliott Bay, mean total PCBs concentrations range from 28 µg/kg dw (2007 data) to 32 µg/kg dw (1991 to 2004 data), and the mean dioxins/furans concentration was 2 ng TEQ/kg dw (2007 data) (see Table 2). Concentrations are higher when 90th percentile values are considered (e.g., 53 µg/kg dw for total PCBs based on 2007 data). Post-remediation concentrations of total PCBs and dioxins/furans in sediment in the EW would be higher than these values because of its closer proximity to diffuse urban inputs, which are more represented by data from inner Elliott Bay.

In summary, all the lines of evidence to determine concentrations that can be achieved in the long term in the EW indicate that the SCO will not be achieved or maintained. For total PCBs, the average concentrations are well above the SCO of 3.5 µg/kg dw, and range of achievable concentrations for all lines of evidence is 9 to 153 µg/kg dw. For dioxins/furans, the average concentrations are well above the SCO of 5.0 ng TEQ/kg dw, and range of achievable concentrations for all lines of evidence is 1.7 to 20 ng TEQ/kg dw. Regional background concentrations, when determined, are expected to fall within this range.

4.2 Net Adverse Environmental Impact

The second factor in determining an upward adjustment of the SCO-based cleanup level is the determination of net adverse impact on the aquatic environment, which takes into account "the short- and long-term positive effects on natural resources, habitat restoration, and habitat enhancement and the short- and long-term adverse impacts on natural resources and habitat caused by cleanup actions" (WAC 173-204-560(2)(a)(ii)(B)).

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[4] Inner Elliott Bay samples are generally defined as samples east of a line from Terminal 91 directly south to West Seattle. Outer Elliott Bay includes the samples west of the line. See the depiction in Appendix J, Figure J-3, of the LDW FS (AECOM 2012).

SMS cleanup levels for total PCBs and dioxin/furans that are not adjusted significantly upward from the SCO could only be met and reliably maintained with additional dredging over larger areas and at greater depths, and repeated capping and redredging of the same areas as concentrations rise due to diffuse source inputs over time. This approach would result in very large adverse impacts on the aquatic environment (natural resources and habitat) from construction without producing any countervailing long-term environmental benefits from the additional cleanup measures (i.e., risk reduction). Repeated rounds of dredging and/or capping would result in major additional construction-related adverse impacts to the benthic community, due to disruption of the established biological active zone, and to fish tissue contaminant levels, due to releases of contaminated material during dredging, resulting in higher fish exposures. In addition, these adverse impacts would occur over a significantly longer period of time. Even with ongoing efforts of this type, evidence presented in Section 4.1 of this appendix suggests that the SCOs for total PCBs and dioxin/furans would still not be achieved. As such, the continued cleanup activities in an attempt to reach concentrations closer to the SCO would result in significant adverse impacts to the environment without commensurate benefits to the benthic community or reductions in tissue concentrations that would lower human health risks. Ultimately, the EW system will equilibrate to incoming sediment concentrations that are higher than the SCO and similar to concentrations resulting from less disruptive cleanup activities associated with higher cleanup levels (e.g., CSL).

In comparison, SMS cleanup levels based on the CSL for total PCBs and dioxin/furans (i.e., regional background, once established) would result in slightly smaller adverse impacts on the aquatic environment from construction because the cleanup technologies needed to meet the cleanup levels would be less intrusive to benthic communities in some areas (less dredging or capping), and the need for additional contingency actions would be greatly reduced or eliminated. A cleanup level at or close to the regional background for total PCBs and dioxin/furans, once established, would reflect the concentrations of those contaminants in incoming sediment over the long term, thereby avoiding unnecessary adverse impacts on the aquatic environment from construction and ultimately resulting in similar or improved long-term environmental benefits from cleanup (i.e., risk-reduction). Therefore, sediment cleanup levels based on SCO will result in net adverse impacts, which would not occur with cleanup levels that are adjusted upward to the CSL based on regional background.

4.3 Summary and Conclusion

Compliance with the SMS will require the adjustment of cleanup levels upward from the SCO to the CSL for total PCBs and dioxins/furans. This adjustment will occur in the future when the CSL (i.e., regional background) is established for these contaminants.

For FS purposes, a hypothetical maximum removal scenario was analyzed to approximate lowest technically possible concentrations for total PCBs that could be achieved following construction. This analysis indicated that approximately 57 µg/kg dw could be achieved (34 µg/kg when making adjustments for bioavailability) when considering limitations to remediating near structures to achieve very low total PCBs concentrations.

Multiple lines of evidence were analyzed to approximate values that could be achieved in the long term. For total PCBs, the average concentrations are well above the SCO of 3.5 µg/kg dw, and range of achievable concentrations for all lines of evidence is 9 to 153 µg/kg dw. For dioxins/furans, the average concentrations are above the SCO of 5.0 ng TEQ/kg dw, and range of achievable concentrations for all lines of evidence is 1.7 to 20 ng TEQ/kg dw. As discussed in Section 4, the cleanup level may not be adjusted above the CSL (i.e., regional background values, once established).

Finally, the net adverse environmental impact for setting the cleanup level at the SCO was qualitatively discussed, indicating that the cleanup levels need to be adjusted upward to the CSL, when established, to avoid environmental disturbances that results in no environmental benefit.

5 SEDIMENT RECOVERY ZONE

Under SMS, a restoration timeframe of longer than 10 years (i.e., cleanup levels not achieved within 10 years) would result in the designation of an SRZ (WAC 173-204-570(5)(b)). SMS define the SRZ as the following:

> *"Sediment recovery zone" means an area authorized by the department within a site or sediment cleanup unit where the department has determined the cleanup action cannot achieve the applicable sediment cleanup standards within ten years after completion of construction of the active components of the cleanup action.*

The SRZ is used to track a cleanup area that remains above cleanup levels and perform additional cleanup or source control actions as necessary. The requirements of the SRZ are listed in WAC 173-204-590(2), are very similar to the CERCLA requirements of the selected remedy, and would be substantively met through CERCLA components of the remedy (e.g., the long-term monitoring and 5-year review framework, and the alternative analysis, comparison, and selection process).

The key components of the SRZ approach, if used, are the following:

- The SRZ would be designated side-wide for relevant human health risk drivers 10 years following construction.
- The Harbor Island Superfund Site 5-year reviews and site-wide monitoring program would provide the periodic review process for adjusting, eliminating, or renewing the SRZ consistent with SMS.
- The SRZ would be used in concert with active cleanup and source control measures for the selected alternative, and would not replace cleanup actions. The contaminant concentrations within the SRZ will be as close as practicable to the cleanup level, based on the CERCLA comparison of alternatives under the nine criteria in the FS.

For the EW, post-construction site-wide monitoring data would be used to evaluate progress toward meeting the cleanup levels. This information could also be used to support establishment or evaluation of regional background concentrations and potential modification of the SRZ and closure of the site.

If monitoring data shows cleanup standards cannot be met, the following options are available for Ecology to consider:

1. *If noncompliance is due to PLP sources not being controlled, additional source control may be necessary.*
2. *If noncompliance is due to contribution from other sources that are not under the responsibility or authority of the PLP, closure of the SRZ may be appropriate or adjustment of the cleanup level may be appropriate. For example:*
   a. *Ecology may consider whether the cleanup level should be adjusted upwards according to the process detailed in Chapter 7, Section 7.2.3. An example of when this may be appropriate is where the cleanup level was established below regional background, but Ecology has since established or approved regional background for the geographic area where the site is located. In this case, Ecology may determine that regional background represents the concentration in sediment that is technically possible to maintain, due to ongoing sources that are not under the authority or responsibility of the PLP. Therefore, Ecology could allow upwards adjustment of the sediment cleanup level to the CSL if regional background has been established as the CSL.*
   b. *If the cleanup levels are based on background (regional or natural), Ecology will consider whether background concentrations have increased and the cleanup level should be adjusted upwards.*

(Ecology 2017, Section 14.2.6)

6 CONCLUSIONS

The PRGs in the EW FS have been developed to be consistent with SMS (WAC 173-204-560). The selected alternative will meet the SMS ARAR over time by achieving the SCO, or by achieving the cleanup level after the establishment of a CSL and upward adjustment of the cleanup level. If cleanup levels are not achieved within 10 years following construction, then the substantive requirements of an SRZ will be met through the CERCLA 5-year review process.

Because it is not known whether, or to what extent, the SMS ARARs for various COCs will be achieved in the long term, or the timing of a potential regional background evaluation, the SMS compliance mechanism is not selected at this time. The method used to comply with the SMS ARAR will depend primarily on the timing of regional background evaluations for the EW and measured site performance following construction.

EPA may also issue a TI waiver at some point in the future if EPA determines that SMS-based cleanup levels cannot be practicably achieved within the EW based on long-term monitoring data and trends. This would be conducted either as part of a ROD Amendment or an ESD.

7 REFERENCES

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Ecology (Washington State Department of Ecology), 2008. Dioxins, Furans, and other Contaminants in Surface Sediment and English Sole Collected from Greater Elliott Bay (Seattle), Publication No. 08-03-017. June 2008.

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Floyd|Snider, 2010. Subject: Requested 5-Year Review Package—Todd Shipyards Sediment Operable Unit. Project Number: Todd-NPL. Letter to Lynda Priddy, U.S. Environmental Protection Agency, Region 10. August 31, 2010.

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Tetra Tech, 2012. Lockheed Shipyard No. 1, Sediments Operable Unit (LSSOU) Harbor Island, Seattle, Washington, 2012 Operations, Monitoring and Maintenance Report. Prepared for Lockheed Martin Corporations. Prepared by Tetra Tech. September 2012.

TABLES

Table 1
Areas and Post-construction Concentrations for Maximum Possible Remediation Evaluation

Area	Area (acres)	Remediation and Residuals Management Approach	Residuals PCBs Concentration (µg/kg dw)	Residuals Thickness (cm)	Resulting Post-construction Concentration	Notes
1 Open-water Areas Away from Offsets, Slopes, and Riprap	114	Two cleanup dredging passes and RMC	141	5.8	10	Residuals concentration and thickness based on residuals approach discussed in WPAM 1, but with two cleanup passes followed by RMC.
2 Underpier Areas	15	Diver-assisted hydraulic dredging followed by in situ treatment	510	10	290 µg/kg dw; 153 µg/kg effective bioavailable	Residuals concentration and thickness based on the Draft FS assumption for dredging down to riprap surface. Post-construction concentration based on volume-weighted average concentration under the pier (510 µg/kg), with a 70% reduction in bioavailability.
3 Keyways	7.0	Dredging to the extent practicable followed by in situ treatment[a]	640	10	364 µg/kg dw; 192 µg/kg effective bioavailable	Residuals concentration and thickness based on the Draft FS assumption for dredging down to riprap surface. Post-construction concentration based on the estimated site-wide average last-pass dredging concentration (760 µg/kg), with a 70% reduction in bioavailability.[a]
4 Structural Slope and Offset Areas	18	Dredging to the extent practicable with RMC	640	5.1	35	Residuals concentration, thickness, and post-construction concentration based on residuals approach discussed in WPAM 1.
5 Under the West Seattle Bridge and the Head of Slip 27 Bridge	2.4	Dredging to the extent practicable with RMC	640	10	10	Residuals concentration based on site-wide average concentration in the last dredging production pass (presented in WPAM 1). Residuals thickness incorporates offsets from bridge structures. Post-construction concentration is assumed to be 10 µg/kg based on minimal resuspension in the relatively quiescent conditions between the low bridges.
6 Under Low Bridges	1.8	Enhanced natural recovery (ENR) (dredging not possible due to access and debris)	640	1.0	8	Area is characterized by large debris and poor access. Dredging would be ineffective without bridge removal. Assume that ENR is used with a post-construction concentration based on a 1-cm residuals thickness from neighboring dredging.
Site-wide Area-weighted Average	157	Varies	262	Varies	57 µg/kg dw; 34 µg/kg effective bioavailable	Site-side SWAC based on the post-construction concentrations and areas above.

Notes:

a. The hypothetical placement of in situ treatment material in keyways is presented for this evaluation. However, some keyway areas are already at the required navigation elevation and placement types/thickness may be limited by the navigation requirements. In addition, long term effectiveness and stability of placement in active berthing areas is highly uncertain because of prop-wash. Reduction in bioavailability is approximated.

µg/kg - microgram per kilogram
cm - centimeter
dw - dry weight
FS - Feasibility Study
PCB - polychlorinated biphenyl
RMC - residuals management cover
SWAC - spatially-weighted average concentration
WPAM - Work Product Approval Meeting

Table 2
Technical Possibility Lines of Evidence

Location	Area Description	PCBs (µg/kg dw) Average (points)	PCBs Median	PCBs 90th Percentile	PCBs n	Dioxin/Furan (ng TEQ/kg dw) Average (points)	Dioxin/Furan Median	Dioxin/Furan 90th Percentile	Dioxin/Furan n	Notes	Citation
East Waterway Input Concentrations											
East Waterway	Weighted average input concentrations (base case)	45	n/a	n/a	n/a	6	n/a	n/a	n/a	From Table 5-5 of the East Waterway Feasibility Study. Methods described in Section 5.3.2 of the Feasibility Study. Based on future conditions.	n/a
	Weighted average input concentrations (low bounding)	9	n/a	n/a	n/a	2	n/a	n/a	n/a		
	Weighted average input concentrations (high bounding)	85	n/a	n/a	n/a	8	n/a	n/a	n/a		
Sediment Remediation Sites											
Pier 53-55, Elliott Bay	Post-remediation cap and ENR surface	32	15	68	7	n/a	n/a	n/a	n/a	Sampled in 2002, year 10 post-remediation (capping and ENR).	King County 2010
Lockheed, Shipyard No. 1, West Waterway	All open channel remediation areas (dredge with/without ENR)	133	102	202	5	n/a	n/a	n/a	n/a	Sampled in 2012, year 7 post-remediation (removal and removal with ENR). Beach samples excluded. Five samples from upper 10 cm.	Tetra Tech 2012
Todd Shipyards, West Waterway	All remediation areas (dredge with/without ENR, capping)	78	44	106	15	n/a	n/a	n/a	n/a	Sampled in 2010, 5 years post-remediation (mixture of open-water dredging, some dredging with ENR, and underpier and nearshore capping).	Floyd|Snider 2010
Duwamish Diagonal, Lower Duwamish Waterway	Caps A and B	54	55	90	8	5.1	5.1	6.6	3	Sampled in 2009, event year 6 post-remediation (capping).	AECOM 2012 (Feasibility Study report and database)
Elliott Bay Concentrations											
Elliott Bay	All of Elliott Bay from 2007 sampling	119	63	250	18	15	5.9	37	18	All Elliott Bay samples in the 0-10 cm interval collected in 2007. Both Outer Elliott Bay data and Inner Elliott Bay as defined by the report.	Ecology 2008
	Inner Elliott Bay only from 2007 sampling	153	184	274	13	20	6.5	73	13	13 samples from the 0-10 cm interval collected in 2007. Inner Elliott Bay as defined in the report.	
	Outer Elliott Bay only from 2007 sampling	28	17	53	5	1.7	1.6	2.9	5	Elliott Bay in the 0-10 cm interval collected in 2007. Outer Elliott Bay as defined in the report.	Ecology 2008
	Outer Elliott Bay only from 1991-2004 sampling events	38	17	82	28	n/a	n/a	n/a	n/a	Data from 1991 to 2004 from EIM database. Inner and Outer Elliott Bay as defined in the report.	AECOM 2012 (Feasibility Study Table J-1)

Notes:

µg/kg - microgram per kilogram
cm - centimeter
dw - dry weight
ENR - enhanced natural recovery
n/a - data not available or parameter not applicable
ng TEQ/kg - nanogram toxic equivalent per kilogram
PCB - polychlorinated biphenyl
Statistics were performed in Excel using standard equations.

References:

AECOM, 2012. Feasibility Study, Lower Duwamish Waterway, Seattle, Washington. Final Report. Prepared for Lower Duwamish Waterway Group. October 2012.
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FIGURES

Q:\Jobs\060003-01 East Waterway SRI-FS\Analysis\2015_08_Max_Alternative\Max_Remed_Areas_Offsets.mxd ckiblinger 1/19/2016 11:14:21 AM

CMA Boundaries
Riprap (No Action)
1 - Unrestricted Dredging Areas
2 - Underpier Areas
3 - Keyway Areas
4 - Structural Slope and/or Offset Areas
5 - Underbridge Areas with Equipment Access
6 - Low Bridges without Access for Dredge Equipment

0 500 1,000

Scale in Feet

NOTES:
Maximum possible sediment removal does not include demolition and reconstruction of structures or structural slopes in the East Waterway.

Figure 1
Areas and Offsets for Maximum Possible Remediation Evaluation
Feasibility Study - Appendix A
East Waterway Study Area

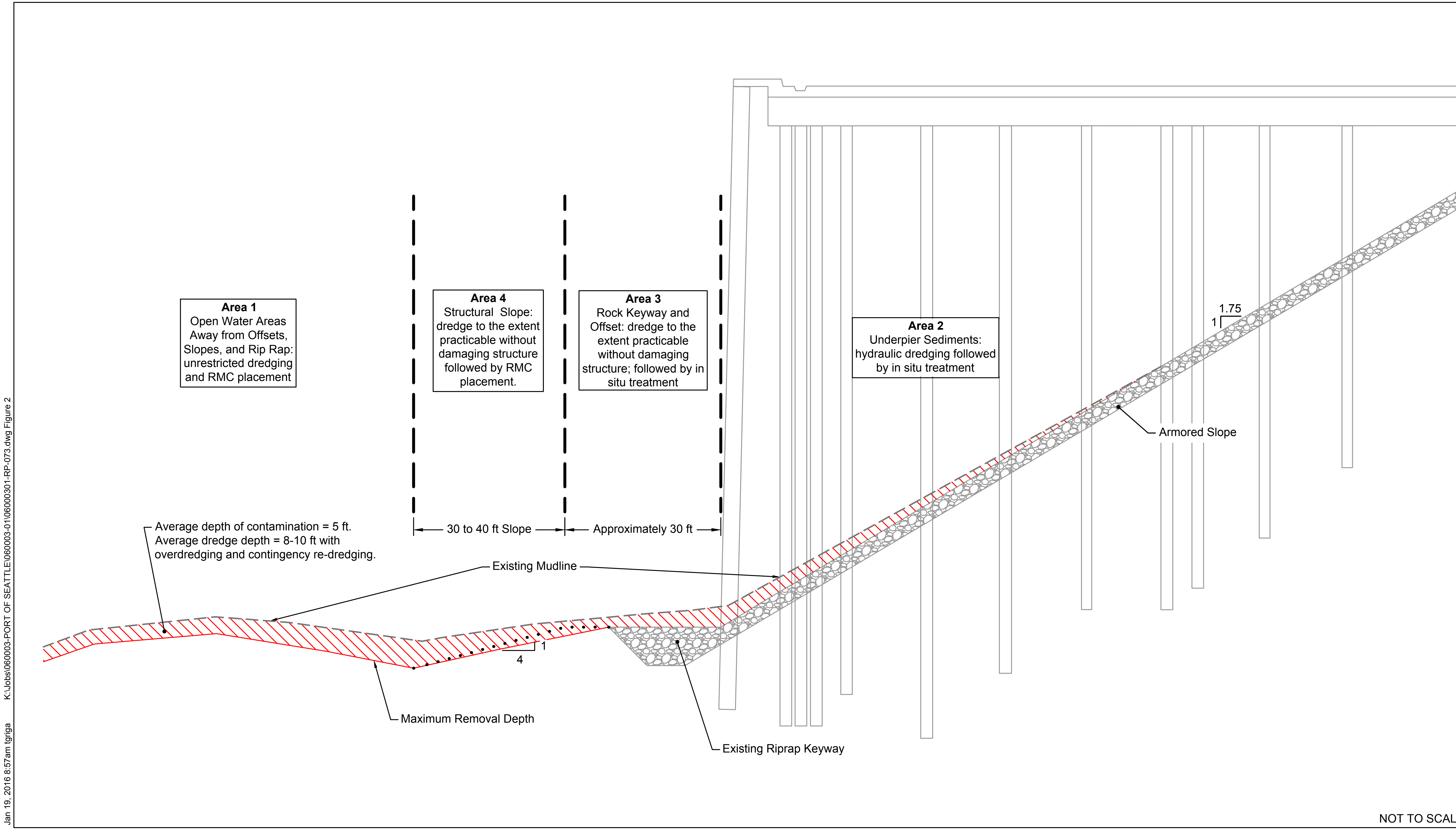

Figure 2

Conceptual Cross Section Showing Maximum Possible Remediation for East Waterway Terminal with Keyway
Feasibility Study - Appendix A
East Waterway Study Area

PART 2: DEVELOPMENT OF SEDIMENT PRGS FOR PCBS IN FISH

Development of Sediment PRGs for PCBs in Fish

Total PCBs were identified in the Baseline Ecological Risk Assessment (ERA) for the East Waterway (EW) site as a contaminant of concern (COC) for English sole and brown rockfish because PCBs in tissues of both fish species exceeded the two lowest observed adverse effect level (LOAEL) toxicity reference values (TRVs) that were associated with adverse effects in fish. Total PCBs were also identified as a risk driver COC for fish based fish tissue concentrations exceeding the higher LOAEL TRV(Windward 2012).

Two LOAEL TRVs for fish were evaluated in the ERA for PCBs because of uncertainties associated with the lowest LOAEL TRV. Both TRVs are derived from Hugla and Thome (1999). The study examined the effects of PCB exposure on reproductive endpoints with fish dosed at two concentrations. During the first reproductive season there was no spawning at the high exposure, and no adverse effects were reported for the lower exposure level. One year following exposure, significant reductions in fecundity were reported at both exposure levels. The fecundity LOAEL associated with the lower dose is uncertain because fecundity as measured after the first two spawning seasons was not dose-responsive. Egg mortality was significantly higher than the control in the higher exposure level but at the lower dose, egg mortality was not significantly different from controls. The uncertainties in this study are detailed in the ERA uncertainty analysis (Section A.6.2.2.2). Uncertainties discussed include those associated with the statistical analysis for the fecundity endpoint and the fact that this endpoint was not dose responsive, uncertainties related to test conditions, and uncertainties in the estimate of the whole-body concentration associated with effects. Total PCBs in fish was the only COC that was evaluated based on two TRVs. In the EW Supplemental Remedial Investigation (SRI), the two TRVs were used to derive two tissue risk based threshold concentrations (RBTC) values from which two sediment RTBC values are derived.

A sediment PRG value for each fish species is needed to evaluate the effectiveness of proposed remediation strategies in the FS. This memo provides the basis for the development of a sediment PRG value for each fish receptor for total PCBs. As discussed in Section 4 of the FS, PRGs are developed based on an evaluation of RBTCs, background concentrations and practical quantitation limits. The analysis presented sediment RBTCs for fish that are above background concentrations for total PCBs and above practical quantitation limits (see Section 4 in the FS), and therefore, the RBTCs are used to set the sediment PRG for total PCBs for fish. Because of the uncertainties in the lower TRV (see ERA Sections A.6.2.2.2), the lower TRV was not used alone to develop the sediment PRG for fish. Instead, two approaches were evaluated for the development of the PRG value, both of which included the use of the lower TRV in combination with other TRVs. The first approach is based on the mean of the tissue

RBTC values from the EW SRI (Anchor and Windward 2013). The second approach is based on the calculation of the 5th percentile of the ERA effects dataset.

The first approach to deriving a sediment PRG for each fish receptor was to use the mean of the two tissue RBTC values (0.52 and 2.64 mg/kg ww) for PCBs in fish. This approach results in a tissue value of 1.6 mg/kg ww, which was then used to derive sediment values for both English sole and brown rockfish using the site-wide EW PCB food web model (FWM). This approach resulted in sediment values of 370 µg/kg dw for English sole and 250 µg/kg dw for brown rockfish.

The second approach was to calculate a percentile value of the TRV dataset for PCBs in fish tissue that was developed in the ERA (Windward 2012). The calculation of a low percentile value from a dataset of acceptable studies of effects is consistent with the approach used in developing ambient water quality criteria (Stephan et al. 1985) and other criteria developed for the protection of special-status species (e.g., Meador et al. 2002).

Thirteen studies with fish tissue LOAELs for the potential adverse effects of PCB mixtures on fish were reviewed in the ERA (Table 1). None of the studies used English sole or brown rockfish. Concentrations of PCBs in fish tissue were reported in 17 species (i.e., Atlantic croaker, Atlantic salmon, brook trout, channel catfish, coho salmon, common barbel, fathead minnow, goldfish, Chinook salmon, pinfish, rainbow trout, mummichog, sheepshead minnow, common minnow, and spot). Adverse effects included reduced body weight; reduced early life stage or fry growth and survival; and reduced fecundity, hatchability, and spawning success following exposure to PCBs.

Whole-body effect-level concentrations ranged over three orders of magnitude across the fish species included in the toxicological studies. Whole-body tissue LOAELs ranged from 0.520 mg/kg ww for reduced barbel fecundity (Hugla and Thome 1999) to 749 mg/kg ww for mortality of fathead minnows (van Wezel et al. 1995).

All LOAEL values were included in the derivation of the percentile value except the results of one study (Table 1). The LOAEL values from van Wezel et al. 1995 were excluded because of the lack of a control in the study design and large variability in the results.

Table 1. Fish whole-body tissue-residue TRVs for PCBs from the EW ERA

Chemical	Test Species	Tissue Analyzed	Whole-body NOAEL (mg/kg ww)	Whole-body LOAEL (mg/kg ww)	Effect	Source	Acceptable for derivation of 5th percentile LOAEL
Aroclor 1260	common barbel	whole body	na	0.520[a]	reduced fecundity	Hugla and Thome (1999)	Yes
Aroclor 1254	juvenile Chinook salmon	whole body	0.980	na	no effect on growth or survival	Powell et al. (2003)	LOAEL na
Aroclor 1260	common barbel	whole body	0.520[b]	2.64[a]	lack of spawning in first reproductive season; egg and larval mortality	Hugla and Thome (1999)	Yes
Aroclor 1254	rainbow trout (14 weeks)	whole body	8.0	na	no effect on growth or survival	Lieb et al. (1974)	LOAEL na
Aroclor 1254	sheepshead minnow (adult)	whole body	1.9	9.3	decreased fry survival in the first week after hatch	Hansen et al. (1974a)	Yes
Aroclor 1254	pinfish	whole body	na	14	reduced survival	Hansen et al. (1971)	Yes
Aroclor 1268	mummichog (adult)	whole body	15	na	no effect on fertilization, hatching, or larval survival	Matta et al. (2001)	LOAEL na
Clophen A50	common minnow	whole body	na	25	reduction in time to hatch, fry mortality	Bengtsson (1980)	Yes
Aroclor 1260	channel catfish	whole body	32	na	no effect on growth or survival	Mayer et al. (1977)	LOAEL na
Aroclor 1254	spot	whole body	27	46	reduced survival	Hansen et al. (1971)	Yes
Aroclor 1260	fathead minnow	whole body	na	50	reduced offspring body weight	DeFoe et al. (1978)	Yes
Aroclor 1254	brook trout embryos	whole body	31	71[c]	reduced fry growth	Mauck et al. (1978)	Yes
Aroclor 1016	sheepshead minnow	whole body	77	na	no effect on fertilization success, survival of embryos, or fry survival	Hansen et al. (1975)	LOAEL na
Aroclor 1016	pinfish	whole body	na	106	50% mortality	Hansen et al. (1974b)	Yes
Aroclor 1254: 1260 mixture	juvenile rainbow trout	whole body	120	na	no effect on survival	Mayer et al. (1985)	LOAEL na

Chemical	Test Species	Tissue Analyzed	Whole-body NOAEL (mg/kg ww)	Whole-body LOAEL (mg/kg ww)	Effect	Source	Acceptable for derivation of 5th percentile LOAEL
Aroclor 1254: 1260 mixture	juvenile rainbow trout	whole body	70	120	reduced growth	Mayer et al. (1985)	Yes
Aroclor 1254	brook trout embryos	whole body	71	125	reduced fry survival	Mauck et al. (1978)	Yes
Aroclor 1254	fathead minnow	whole body	na	196 (male)	reduced spawning	Nebeker et al. (1974)	Yes
Aroclor 1016	sheepshead minnow fry	whole body	77	200	reduced fry survival	Hansen et al. (1975)	Yes
Clophen A50	goldfish	whole body	na	250	lethal body burden	Hattula and Karlog (1972)	Yes
Aroclor 1242, 1254, or 1260	fathead minnow (6 months)	whole body	na	1.86 – 749	range of lethal body burdens (concentration associated with mortality of individuals)	van Wezel et al. (1995)	No

[a] Whole-body NOAELs and LOAELs were estimated using egg-to-adult conversion factors for studies that reported concentrations in eggs rather than whole-body tissue.

[b] Whole-body tissue residues were the weighted sum of 10 different tissues (i.e., blood, brain, muscle, skin, liver, gonads, adipose tissues, kidney, digestive tract, and skeleton) (Leroy 2007). Tissue concentrations were converted from dry weight to wet weight assuming 20% solids; all endpoints except first reproductive season spawning were evaluated 1 year after exposure.

[c] At the LOAEL, growth was significantly less than control at 48 days after hatching but not at 118 days after hatching. At NOAEL and LOAEL concentrations, study provides tissue concentrations only after 7 days and 118 days of exposure. LOAEL and NOAEL are tissue concentrations in fry at 118 days post hatch. Tissue concentrations at 7 days post-hatch associated with no effects (1.8 mg/kg ww) and low effects (3.2 mg/kg ww) were lower than the concentration at 118 days post-hatch.

ERA – Ecological Risk Assessment
EW – East Waterway
LOAEL – lowest-observed-adverse-effect level
na – not available
NOAEL – no-observed-adverse-effect level
PCB – polychlorinated biphenyl
TRV – toxicity reference value
ww – wet weight

The 5th percentile LOAEL value was calculated using fourteen whole-body LOAEL values from the ERA TRV dataset (Table 2). The 5th percentile of the LOAEL values is 1.9 mg/kg ww (Figure 1).

Table 2: LOAEL values used in calculation of 5th percentile LOAEL

Source	Whole-body LOAEL (mg/kg ww)
Hugla and Thome (1999)	0.520
Hugla and Thome (1999)	2.64
Hansen et al. (1974a)	9.3
Hansen et al. (1971)	14
Bengtsson (1980)	25
Hansen et al. (1971)	46
DeFoe et al. (1971)	50
Mauck et al. (1978)	71
Hansen et al. (1974b)	106
Mayer et al. (1985)	120
Mauck et al. (1978)	125
Nebeker et al. (1974)	196
Hansen et al. (1975)	200
Hattula and Karlog (1972)	250

LOAEL – lowest-observed-adverse-effect level
ww – wet weight

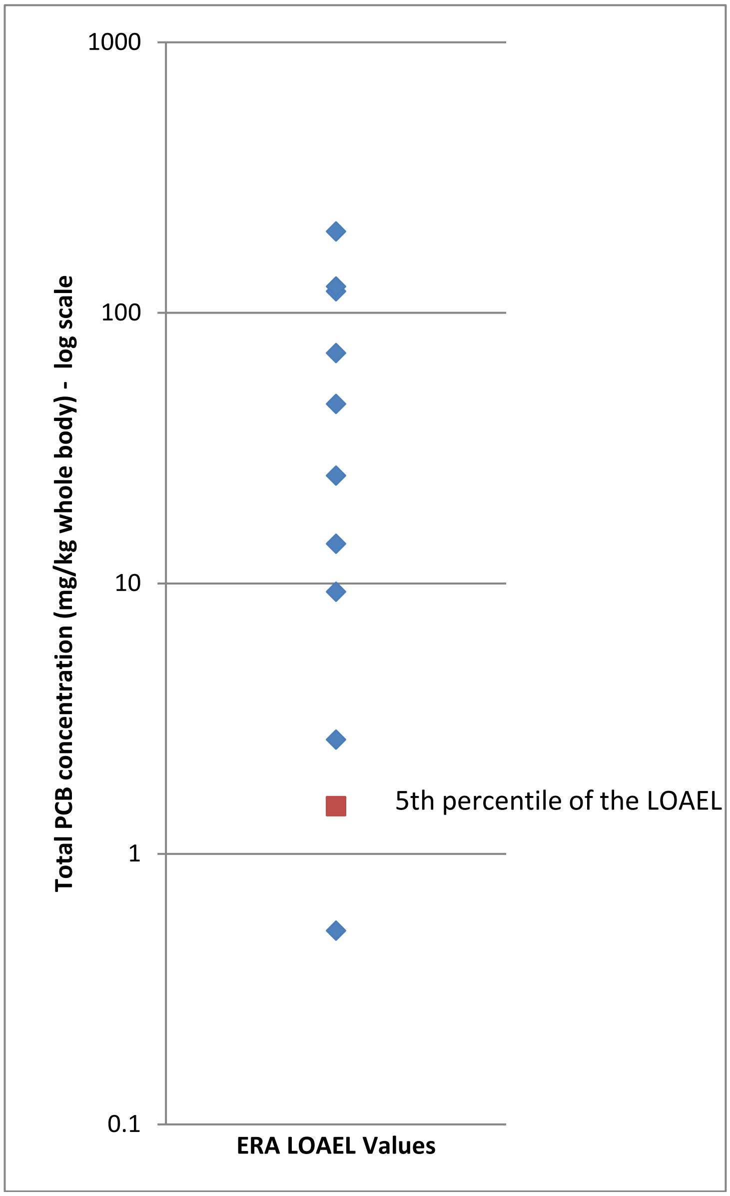

Figure 1: LOAEL TRV values and 5th percentile value

The tissue value of 1.9 mg/kg ww was then used to derive sediment values for both English sole and brown rockfish using the site-wide EW FWM for PCBs. This approach resulted in sediment values of 450 µg/kg dw for English sole and 280 µg/kg dw for brown rockfish.

The sediment values derived from the mean of the tissue RBTCs and the 5th percentile of the tissue TRV dataset are provided in Table 3. The values are within a factor of two of each other, which is within the bounds of food web model predictability (typically within a factor of 2 to 5). Because these values are subject to all the uncertainties associated with the food web model, the sediment values are not considered significantly different from one another. Based on this analysis and considering the uncertainties in the lowest LOAEL TRV, the sediment PRGs for fish are derived based on the sediment values calculated from the mean of the two tissue RBTCs. These values are above background sediment concentrations for PCBs (see Section 4 of the FS) as well as practical quantitation limits. Therefore, the sediment PRG for English sole is 370 µg/kg dw and the sediment PRG for brown rockfish is 250 µg/kg dw.

Table 3: Total PCBs Sediment PRG values for English sole and brown rockfish

Fish ROC	Sediment value(µg/kg dw) based on mean of tissue RBTCs	Sediment value (µg/kg dw) based on 5th percentile of TRV dataset	Selected Fish Sediment PRG
English Sole	370	450	**370**
brown rockfish	250	280	**250**

µg/kg dw – microgram per kilogram dry weight
PRG – preliminary remediation goal
RBTC – risk-based threshold concentration
ROC – receptor of concern
TRV – toxicity reference value

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EXHIBIT 5

Harbor Island Superfund Site – Sediment Operable Units

Timeline

September 8, 1983	Harbor Island listed on National Priorities List due to concerns regarding upland lead contamination from an operating smelter
1988	EPA completes an initial investigation of marine sediments around Harbor Island as part of the Elliott Bay Action Program.
1987-1991	EPA seeks agreements with potentially responsible parties for remedial investigation/feasibility study (RI/FS) work at portions of the Site, with limited success. As a consequence, an EPA contractor produces an RI for the East and West Waterways in 1993 and an FS in 1994. EPA recognizes significant technical problems with that RI/FS, including the collection of non-representative data, and decides to re-start the RI/FS process.
1995	The Port of Seattle assembles a group of additional Harbor Island PRPs, comprised of other shoreline property owners, who jointly sign an administrative order on consent (AOC) to conduct a sediment sampling and bioassay program for the East and West Waterways. That investigation aligns more closely with Ecology's Sediment Management Standards than the earlier version conducted by EPA's contractor.
1998	The Port, Lockheed and Todd sign a new AOC to conduct bioaccumulation testing as a follow-up to the prior sampling and bioassay program.
2003	The work completed under the 1995 and 1998 AOCs results in a 2003 Record of Decision for the West Waterway, which requires no action, and a conclusion that additional investigation of the East Waterway will be necessary.
2003-2005	Following completion of the supplemental remedial investigation work required by the 1995 and 1998 AOCs, the Port and EPA discuss options for expediting cleanup of the East Waterway. Those discussions result in the Port, as the sole participating PRP, entering into a new AOC for a non-time critical removal action (NTCRA) that will remediate the most contaminated accessible portions of the East Waterway. The Port completes that NTCRA in 2005.
2006	The Port signs a fourth East Waterway AOC intended to finally complete an RI/FS. Due to the abundance of existing data and the very few

	available remedy options, EPA assures the Port that an expedited process will be possible.
2006	Based on the Port's discussions with EPA concerning a streamlined supplemental RI/FS process, the Port, City and County opt to settle with Seattle Iron and Metals for what - at the time - is anticipated to be its share of RI/FS costs (an amount significantly less than the actual costs incurred to date, 12 years later). The City and County choose not to sign onto the SRI/FS AOC, but agree to share in the cost of its production with the Port and to provide technical assistance. The Port, City, and County form the "East Waterway Group" (EWG) for this purpose. With these agreements in place, the Port and EPA enter into the Supplemental RI/FS AOC in 2006.
2008-2010	The Port attempts to streamline implementation of the 2006 AOC by collaborating with EPA to collect sufficient information in the Supplemental RI process to allow work on the FS to begin prior to issuance of a final RI.
2012-2014	Work on the FS begins in 2012. The Supplemental RI is finalized in 2013, along with the first draft of the FS. The Port provides the draft FS to EPA in three parts (Sections 1-4 on November 8, 2013; Sections 5-6 on September 20, 2013; Sections 7-11 and appendices on January 31, 2014). The first draft of Appendix A is submitted with the final sections of the Draft FS in January 2014. It provides an estimate for a regional background PCB concentration, which was developed based on Sediment Management Standards criteria and multiple lines of evidence.
2015	In April 2015, EPA requires that the regional background estimate included in Exhibit A be replaced with an evaluation of the "lowest achievable concentration that can be practicably achieved at time zero."[1] The Port works collaboratively with EPA on that "maximum remediation" analysis, the results of which are included in a revised Appendix A submitted with the Draft Final FS in October 2016.
October 2016	After years of discussions and more than 21 formal comment resolution and work product approval meetings, the Port submits the Draft Final FS to EPA in October 2016. As with the first version of Appendix A, the October 2016 version includes information regarding how Ecology

[1] This quote is from agreed-upon meeting notes from the EPA/Port April 27, 2015 comment resolution meeting. "Time zero" refers to the point in time immediately following completion of active remedial measures such as sediment dredging or capping.

	implements its Sediment Management Standards, including references to appropriate Ecology guidance.[2]
	EPA requires relatively minor changes to the Draft Final FS for the production of the Final FS. Appendix A retains the analysis of the lowest achievable concentration, as well as citations to SCUM II. EPA's only notable change to Appendix A was to describe Ecology's SCUM II guidance as "to be considered" information, rather than as an ARAR.
October 20, 2017	The Port and EPA meet to discuss how the FS, including Appendix A, will describe the Sediment Management Standards and ARAR compliance, and agree on the language to be used in the Final FS.
November 3, 2017	The Port submits the Final FS to EPA.
Early 2018	EPA and the Port meet a few times to discuss relatively minor changes to the Final FS.
June 6, 2018	Having previously agreed to the language in Appendix A, EPA now reverses course and instructs the Port to either accept a new, substantially edited version or delete the appendix entirely. Neither option is acceptable to the Port.
June 28, 2018	EPA approves the FS upon the direction that its newly-required modifications be made, including the substantial revisions to Appendix A that EPA had shared with the Port three weeks earlier. EPA's approval letter also requires that all references to natural background levels and PQLs developed by Ecology be removed from the FS, along with all references to "Ecology guidance as a basis for any decisions made by the EPA."

[2] Ecology's primary guidance document for implementation of the Sediment Management Standards is the Sediment Cleanup User's Manual II, also referred to as "SCUM II." EPA disagreed with Ecology's statistical methodology provided in SCUM II for calculating natural background concentrations and required the Port to use EPA's preferred statistical method (which produces lower values). EPA agreed, though, to allow references to Ecology's method to remain in Appendix A for context and transparency.

EXHIBIT 6

EAST WATERWAY HARBOR ISLAND SUPERFUND SITE CLEANUP – CLEANING UP THE ENVIRONMENT, WHILE IMPROVING COMMERCE FOR THE PORT OF SEATTLE

Ravi Sanga[1]

ABSTRACT

In 2003, the EPA entered into an agreed order with the Port of Seattle (Port) to address sediment contamination in the East Waterway Operable Unit of the Harbor Island Superfund Site in Seattle, Washington, per the process defined by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), or Superfund. Based on a review of preliminary data collected, EPA determined that a non-time critical removal action was warranted for a portion of the East Waterway that covered approximately 8.1 hectares (20 acres) in the southern portion of the waterway. The Port of Seattle conducted the removal action that involved mechanically dredging 208,736 cubic meters (273,000 cubic yards) of sediment to meet cleanup standards and achieve navigation channel depths. Dredged material was disposed of at an open-water disposal site and at an upland landfill, based on characterization data. This removal action covered two dredge seasons and included the following goals, restrictions and controls:

- Achieving State standards for chemical concentrations in the newly exposed surface sediments
- Minimizing sediment re-suspension and recontamination with appropriate Best Management Practices and water quality monitoring
- Restricting dredging during "fish window" closure periods
- Attaining the required depth in the working navigation channel

Following the dredging, a 15.2 cm (6-inch) clean sand layer was placed over those areas where initial post dredge sampling indicated that the post removal surface exceeded cleanup levels. Next steps for a full investigation of the East Waterway will include a remedial investigation and feasibility study that will include the post removal area.

This manuscript includes the cleanup successes, ultimate lessons learned with a removal action that benefited both the environment and day-to-day commerce for the Port, the unique coordination efforts between regulatory agencies (both State and Federal) and the responsible party and the dredge contractors, and finally, next steps for the investigation that will lead to a final cleanup decision for the waterway.

Keywords: Sediment dredging, superfund, NTCRA, agency coordination

INTRODUCTION

The East Waterway sediment operable unit (OU) is the only operable unit of the Harbor Island Superfund Site in Seattle, Washington for which the U.S. Environmental Protection Agency (EPA) has not made an OU cleanup decision for contaminated sediments. A non-time-critical removal action was completed by the Port of Seattle (Port) under EPA authority for this OU in March 2005. This resulted in the removal of 208,736 cubic meters (273,000 cubic yards) of contaminated sediment of which 75% was transported to an upland disposal facility and 25% was permitted for open-water disposal. This action resulted in the removal of a large volume of contaminated sediment as well as improving navigation in the channel to the Federally authorized navigation depth of -15.5 m (-51ft) MLLW.

The success of the removal action was due in large part to the close coordination between EPA and the Port throughout the removal process. Close coordination throughout the design and implementation of this project resulted in the efficient and effective management of issues relating to the dredging operation as well as the post-dredge monitoring data. Specific examples include:

- A contingency action, which involved dredging one additional one foot of material and placing an interim remedy consisting of a six inch sand layer, was developed as part of the project design documents and

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contractor bid package for areas where the sediment chemistry exceeded cleanup standards in the post dredge monitoring (PDM) sampling.

- The presence of EPA and EPA's contractors at weekly construction meetings to monitor project progress and assist in the resolution of issues.
- Daily updates on dredging operations and water quality monitoring provided to EPA and contractors.
- The evaluation of PDM data within 72 hrs of data collection in order to identify areas that required placement of clean sand as an interim remedy. The interim remedy was implemented rapidly. The placement of the clean sand layer was completed within weeks of the completion of the dredging. This rapid implementation resulted in greatly reduced potential for ecological exposure to the contamination in the newly exposed sediment surface.

This paper presents the dual successes of the project that resulted in the removal of a large amount of contaminated material from the environment, while deepening the navigation channel so that access to the waterway for large commercial vessels could continue and increase.

BACKGROUND

Since the early 1900s, the former Duwamish River corridor and the surrounding floodplains were filled and graded to form the present-day topography. Dredging in 1903-1905 created the East and West Waterways of Harbor Island, and dredged material from the river was used to create Harbor Island itself. The present urban and developed shoreline is primarily composed of piers, riprap bank lines, and constructed bulkheads for industrial and commercial use. Harbor Island is a man-made island in the mouth of the Duwamish River—near downtown Seattle—that is home to numerous industrial enterprises, including the Port of Seattle (Port) container terminal. Extensive industrial activity on Harbor Island caused its soil, underlying groundwater, and nearby marine sediments to become contaminated with various industrial contaminants, including lead and other toxic metals, pesticides, petroleum hydrocarbons and polychlorinated biphenyls.

The sediment bed of East Waterway is owned by the State of Washington and managed by the Department of Natural Resources. The East Waterway is channelized, has a south-to-north orientation, and is approximately 1,768 m (5,800 ft) long and 244 m (800 ft) wide. Decades of discharge from storm water outfalls, combined sewer overflows and historical industrial emissions and waterway effluents have contaminated the bottom sediments of the waterway with polychlorinated biphenyls (PCBs), heavy metals and pesticides that exceed the Washington State Department of Ecology (Ecology) Sediment Management Standards (SMS).

PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS

In 1998 as a prerequisite for the East Waterway Channel Deepening Project, the Port completed sediment characterization that was conducted under the Dredge Materials Management Program (DMMP) an interagency program, including the U.S. Army Corps of Engineers, EPA and the Washington State Department of Ecology and Department of Natural Resources, which oversees the disposal and beneficial use of sediments dredged from the waters of Washington State. The project area was split into two areas and two stages based on the results of the sediment characterization. The Stage 1 area was identified as an area of generally lower contamination in the northern portion of the waterway. The Stage 2 area was located in the southern portion of the proposed dredge area and contained more contaminated sediment. The Port proceeded with the dredging of the Stage 1 area from December 1999- February 2000 under a USACE permit under Section 10/404 of the Clean Water Act. The Stage 2 area was not dredged at that time. A month after the dredging was completed, post-dredge monitoring was conducted to characterize the new sediment surface. The results showed that the chemical concentrations in the sediments had generally decreased, although not as much as expected, and the sediment bioassays showed an increase in toxicity.

In 2003, the Port compiled the existing sediment data for East Waterway, which included the Channel Deepening sediment characterization data and delineated eight areas of potential concern in an Engineering Evaluation/Cost Analysis (EE/CA) (Windward 2003) that was submitted to the EPA. The goal of the EE/CA was to identify any areas with elevated levels of contaminants that could be sufficiently characterized to be dredged as a non-time critical removal action (NTCRA) under the EPA Comprehensive Environmental Response Compensation and Liability Act (CERCLA) authority, where the clean up standards were Ecology's State Sediment Management Standards (SMS). The area identified as containing the highest levels of contamination was a portion of the Stage 2 area from the 1999 Channel Deepening dredging project and was approximately 8.1 hectares (20 acres) in size (Figure 1). Although sufficient data didn't exist to make a CERCLA waterway-wide cleanup decision, the EPA and the Port entered into a subsequent Superfund legal order in order to move forward with the NTCRA to clean up contaminated sediments. The targeted depth of removal was determined based on both the vertical extent of contamination and the use of the waterway for navigation of large container vessels (-15.5 m (-51 ft) MLLW).

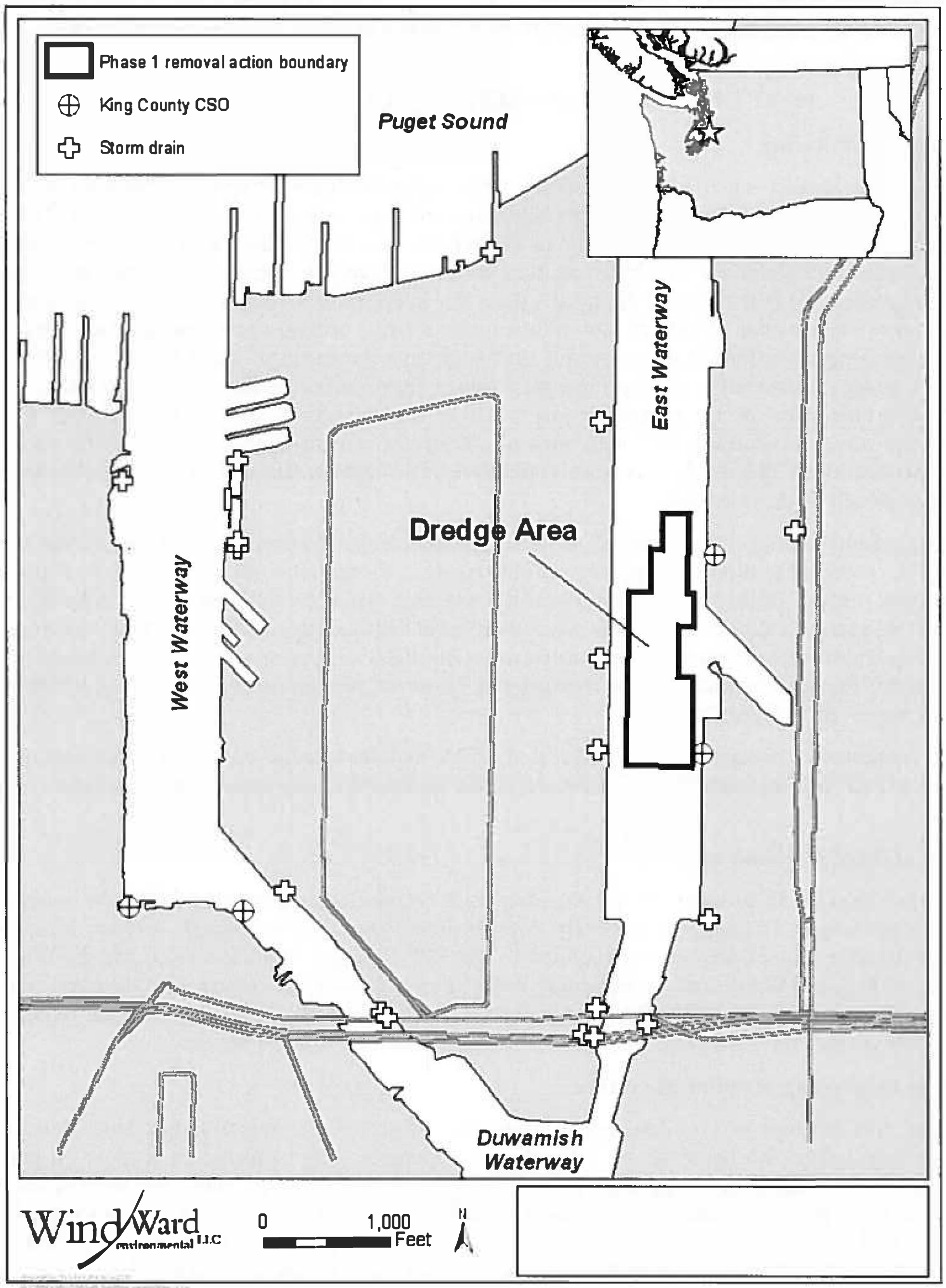

Figure 1. East Waterway with the Stage 1 removal action dredge boundary.

The CERCLA NTCRA process, based on the Superfund Accelerated Cleanup Model (EPA 1993) enabled EPA and the Port to take advantage of the available sediment data to identify an area of concern that could be addressed immediately rather than waiting for the completion of a site-wide RI/FS process that would require the full delineation of human and ecological risk, evaluation of remedial action objectives, remedial alternatives, including treatment and ultimately the feasibility of those alternatives in order to select a waterway-wide final remedy. The NTCRA enabled EPA to provide enforcement direction to the Port for the removal of a large volume of contaminated material from the site and thus improve the environment and protect human-health as well as resulting in the increase of the navigability of the channel in the removal area to the final navigation depth of -15.5 m (-51 ft) MLLW.

PORT OF SEATTLE AND AGENCY COORDINATION SUCCESS

Water quality monitoring

Water quality exceedances due to elevated turbidity in the water column were measured throughout both seasons of dredging. Water quality exceedances have often been assumed to result from dredging operations such as cycle time or dredging speed or the nature of the dredging equipment used by the contractor (e.g., open bucket or closed bucket). Because an attempt was made during this project to correlate operational factors with measured water quality exceedences, the Port and EPA designed a three-day hydroacoustic monitoring study. The goals of the study were to observe the behavior of the turbidity plume under a range of tidal conditions and to determine if specific changes in dredging operations (e.g., decreasing and increasing the speed of the dredging operations) resulted in changes in the observed turbidity. The hydroacoustic data collected indicated that varying these changes in dredging operations had little effect on the magnitude and extent of the turbidity plume. However, due to the difficulty in scheduling the survey to coincide with both optimal tide cycles and dredging of the most silty and contaminated material, the results of this study were not conclusive. The hydroacoustic data did clearly document plume movement upstream on the flood tide.

The physical characteristics of the dredged material appeared to be the determining factor in the occurrence and intensity of the observed turbidity exceedances. In several areas, the material was consistently fine-grained with high organic carbon content. Highly organic and flocculent material was observed in the water column when dredging occurred in these areas, and turbidity plumes were observed at distances up to 300 and 400 meters from the dredging operation. Modifications to dredging operations were not observed to demonstrably affect the extent of the turbidity plume when this fine-grained material was encountered. However, the application of dredging BMPs was critical to minimizing overall turbidity at the site.

Extensive coordination occurred between the Port, EPA and the dredge contractors that included immediate notification to EPA of water turbidity exceedances, which facilitated timely and efficient resolution of water quality issues.

Protection of listed salmonid species

In-water construction in East Waterway and the Duwamish corridor is not permitted during the outmigration period for juvenile salmonids. Dredging is generally not permitted from March through August. Monitoring for the presence of juvenile chinook salmon was required by the U.S. Fish and Wildlife service and the Washington State Department of Fish and Wildlife at the beginning and end of each dredging season. Fish data was reported to EPA and the agencies on a weekly basis. The monitoring results remained in compliance with the requirements of the biological opinion issued for the project by the U.S. National Marine Fisheries Service.

Post-dredge monitoring of sediment surface

EPA and the Port developed a post-dredge monitoring plan as part of the project design documents. Following the post-dredge monitoring plan approval, by EPA, sediment samples were collected from the 1-10 cm interval and analyzed in order to characterize the final dredged surface immediately following the completion of dredging. Analytical data was provided within 24 hours and EPA and the Port met within 72 hrs to identify areas that required contingency dredging and the placement of a clean sand layer as an interim remedy to reduce potential exposure to sediment contamination that still exceeded cleanup standards. Following the contingency dredging of one additional foot of sediment and prior to the placement of the sand layer, additional post dredge monitoring was performed. This data will prove useful with cleanup decisions for the entire waterway that will include reassessing the removal action footprint. The placement of a layer of sand was determined to be an appropriate interim remedy for approximately two thirds of the total project area (Figure 2). The interim remedy was completed within weeks of the completion of the dredging due to the fact that the post-dredge monitoring plan and the interim remedy design were completed as part of the project design document which resulted in rapid implementation and completion of the interim remedy.

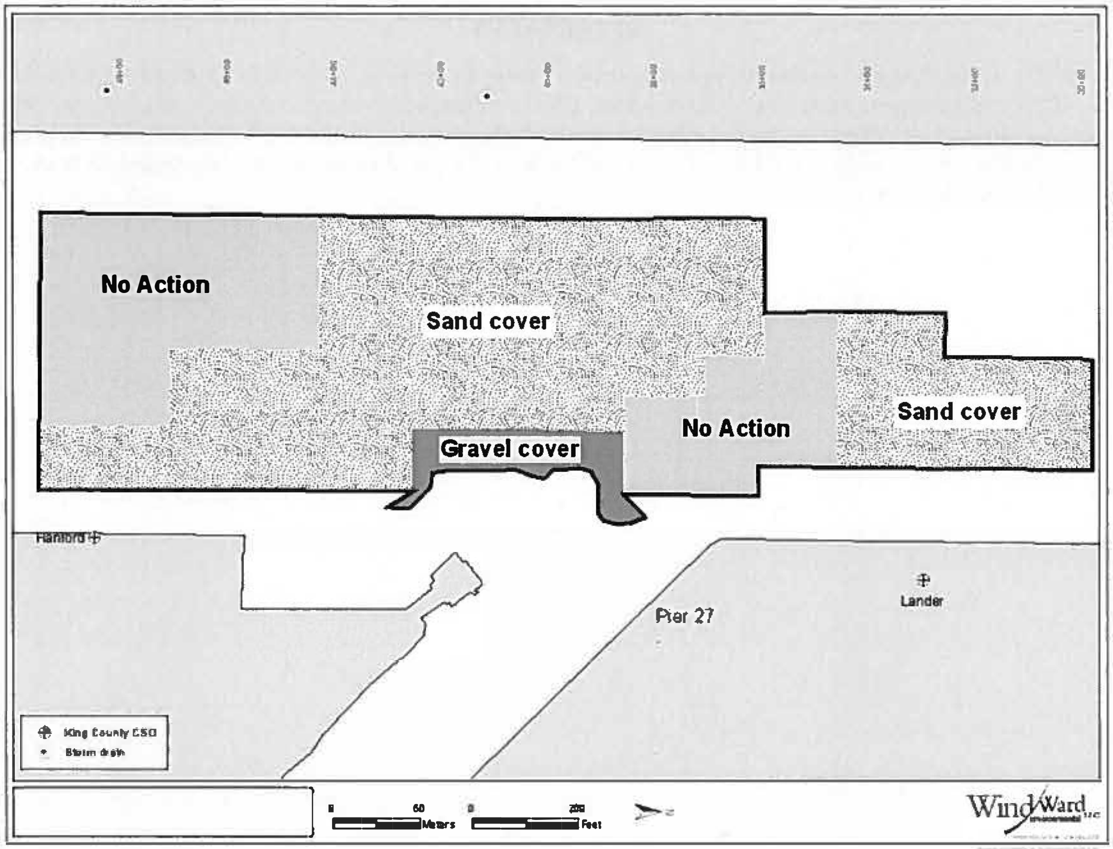

Figure 2. The selected interim remedies for areas within the dredge outline.

This dredging project resulted in both the removal of a large volume of contaminated sediment as well as the achievement of a deeper navigational depth. What was unique with this cleanup was the high level of coordination between agencies, responsible parties and dredge contractors. The success of this project was due largely to the unique and exemplary coordination efforts by all participants that included weekly project team meetings with EPA, the Port and the dredge contractor and associated technical consultants. All parties became aware of issues, as they arose, such as turbidity exceedances from water quality monitoring, dredging areas with harder substrate and equipment failures. This allowed the Regulatory and private sectors to work together to reach resolutions expeditiously, allowing the cleanup schedule to be met.

NEXT STEPS

The East Waterway operable unit supplemental remedial investigation and feasibility study (RI/FS) will begin in 2006. This RI/FS will include additional investigations specific to the East Waterway as well as human and ecological risk assessments, studies on the fate and transport of sediments and an analysis of feasible remedial alternatives that will be incorporated into a Record of Decision for a waterway-wide cleanup. EPA intends to accelerate the next phase of the waterway wide investigation in the hopes that a cleanup decision can be reached as expeditiously as possible.

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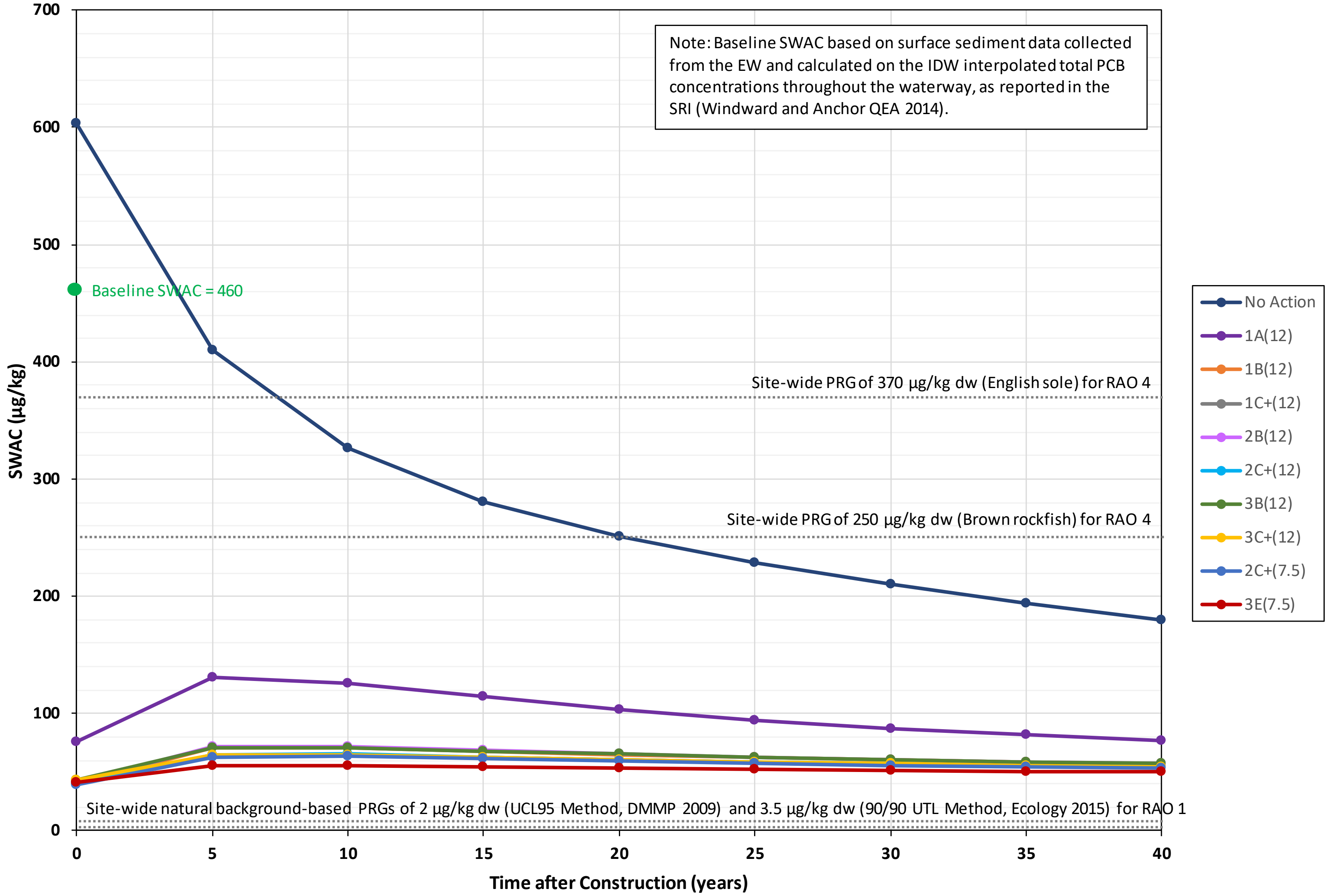
Windward. (2003). East Waterway, Harbor Island Superfund site: Nature and extent of contamination. *Engineering evaluation/cost analysis for East Waterway*. Prepared for the Port of Seattle. Windward Environmental LLC, Seattle, WA.

EXHIBIT 7



90/90 UTL = 90% upper tolerance limit confidence bound on the 90th percentile of the distribution
µg/kg = microgram per kilogram
dw = dry weight
IDW = inverse distance weighting
PCB = polychlorinated biphenyl
RAO = remedial action objective
SRI = Supplemental Remedial Investigation
SWAC = spatially-weighted average concentration
PRG = preliminary remediation goal
UCL95 = 95% upper confidence limit on the mean

Figure 9-1a
Predicted Site-wide SWAC for Total PCBs Over Time
Feasibility Study
East Waterway Study Area

EXHIBIT 8

East Waterway (EW) Feasibility Study (FS) Comment Resolution Meeting Summary (Revised Draft)

This meeting summary is intended to document preliminary consensus on key FS comments and to facilitate communication (and ultimate resolution) on unresolved topics. It is recognized that the preliminary consensus and "path forward" presented herein is subject to change as the comment resolution process proceeds.

Meeting #3. Monday, 4/27/2015. Remedial Technologies to be used in the FS
Meeting Summary by East Waterway Group (EWG), 7/16/15

Discussion Topics

1. Status of Meeting #2 Summary
2. Dredging
    a. Effectiveness and practicability of dredging to achieve natural background (EPA Alternatives Memo Alternative 4, Cmt. 262, 398)
    b. Residuals management options (Cmts. 7, 262, 411)
    c. Water management assumptions (Cmts. 229, 247, 389, 390)
    d. Underpier dredging (EPA Alternatives Memo)
3. Activated Carbon: use of in situ treatment and addition of AC or TOC to ENR and RMC (EPA Alternatives Memo; Cmts.7, 15, 23, 27, 187, 226, 256, etc.)
4. Capping
    a. Cap thickness, need for sensitivity analysis of cap design (Cmt. 250, 381, 383)
    b. Capping assumptions (where it could be used) (Cmt. 385)
5. Definition of ENR and the use of thicker ENR layers in mixing areas (ENR-nav) (Cmts. 222, 236)
6. ENR and MNR technology assignment assumptions and relationship to sedimentation and practicability (Cmts. 28, 71, 258)
7. Define Meetings #7 and #8

Meeting Summary

1. **<u>Status of Meeting #2 Summary</u>**

    - *EWG submitted the Meeting #2 Summary to EPA on 4/24/15. It contains EWG and EPA main discussion points and path forward for each item. EPA will review it and provide comments/edits, and Meeting #2 Summary will be discussed later, possibly during the Monthly EPA Call on 5/5/15.*

2. **<u>Dredging</u>**
    a. **<u>Effectiveness and practicability of dredging to achieve natural background (EPA Alternatives Memo Alternative 4, Cmt. 262, 398)</u>**

    Summary of EWG discussion points:
    - *Full removal of all contaminated sediment is not technically implementable due to structural and physical limitations adjacent to piers, bridges, sheetpile walls, bulkheads, engineered slopes, rip-rap slopes and keyways, and the communication cable crossing.*
        - *The option of full removal of all piers and structures along the EW to maximize contamination removal was screened out in the Alternatives Memorandum due to technical and administrative implementability associated with structural modifications and disruption to current waterway use.*
    - *Natural background for PCBs and other COCs cannot be achieved at the completion of construction because of several processes:*
        - *Resuspension of generated dredge residuals during RMC placement*
        - *Resuspension of undredged residuals or sediments where dredging cannot be conducted for structural reasons*
        - *Sediment deposition from ongoing upstream and lateral inputs (even after source control)*
        - *Resuspension from prop wash mixing of areas still to be remediated during the construction duration (estimated to be over 10 years for the larger alternatives)*

- *Resuspension from prop wash mixing of areas with RMC placement before placement is complete (estimated to take 2 construction seasons for most alternatives).*
- *The LDW was not required to dredge/remediate to natural background. A long-term model-predicted concentration was used instead for the evaluation of alternatives. The lowest RAL was set based on the "tipping point" where further remediation would not reduce long term concentrations.*

Summary of EPA Team discussion points:

- *EPA agrees that the LDW may not reach natural background after construction and recognized significant uncertainty exists in long term predictions based on modeling. The EW FS needs to include similar language regarding uncertainty in predictions.*
- *EPA does believe that enough information has been presented at the current time to substantiate that natural background cannot be achieved at time zero. If natural background is achieved temporarily then there is a high probability for recontamination over time.*
- *EPA is in agreement that natural background is likely not to be maintained in the long term even if a time zero concentration of natural background is achieved.*
- *However, EPA requires that the EW FS include an alternative with actions targeted at achieving the lowest achievable PCB concentration as close as possible to natural background at time zero. The FS needs to provide a defensible argument to support that concentration. This alternative will need to be compared in the evaluation of alternatives.*
- *EPA wants the FS to include more analysis to estimate what is achievable at completion of construction (time 0) and in the long-term. EPA wants to make sure uncertainty in modeling is acknowledged in any assessments of what the predicted long-term sediment condition is.*
- *Other alternatives will need to be designed to meet the lowest achievable concentration that can be maintained in the long term.*

Path forward:

- *An evaluation of the lowest achievable concentration that can be practicably achieved at time zero will be included in the Draft Final FS. This evaluation will be reviewed with EPA in a Work Product Meeting to determine how the analysis will affect FS Alternatives. Specific design of other alternatives and alternative evaluation metrics (e.g., comparison to the long term predicted concentration) will be discussed with EPA during work product approval meetings.*
- *EPA and EWG agree that language regarding the uncertainty of the long-term model-predictions need to be included in the FS, similar to the LDW FS.*
- *This topic will be revisited in the context of remedial alternatives in Comment Resolution Meeting #5.*

b. <u>Residuals management options (Cmts. 7, 262, 411)</u>

Summary of EWG discussion points:

- *EWG is concerned about setting unrealistic expectations regarding the outcome following RMC.*
  - *Remediation will occur over many construction seasons, with final placement of RMC over 2 seasons for all but the least aggressive alternative (if performed as the last construction step). Natural background cannot be achieved with RMC before a year 2 placement can be completed because 1) resuspended sediment from dredge residuals and unremediated areas will be distributed to recently covered areas, and 2) incoming sediment depositing will result in sediment concentrations higher than natural background.*
  - *Multiple cleanup dredging passes have been shown to have diminishing returns because residual contamination tends to be associated with fine colloidal material that is more likely to resuspend during dredging. This has been demonstrated on dredging projects nationally and locally, including at the Port of Everett, in which 2nd and 3rd passes were conducted, but residuals were only reduced significantly during the 1st pass.*
  - *In rip-rap areas such as keyways and underpier slopes, the presence of a hard material layer will increase both the percent loss during dredging and material left behind. RMC also cannot be*

placed on riprap keyways in some terminals because they are at the maintained berthing elevations. On underpier slopes, RMC would be difficult to keep in place due to steep grades.
- *The limitations of adding AC to RMC are discussed below in Meeting Topic #3.*
- *RMC thickness is typically a design specification contingent on post-dredging sampling and monitoring results. It was assumed a 9-in thickness in the FS only for costing purposes, but it will be specified during remedial design.*
- *The Draft FS already includes a realistic RMC program performed at the end of construction.*

Summary of EPA Team discussion points:
- *EPA reiterated comments that additional residuals management approaches need to be explored as sub-alternatives in the FS, including multiple dredge passes after construction completion, thicker RMC layer placement, and inclusion of GAC in RMC, to get as close as possible to natural background.*
- *The EWG needs to define the assumed contaminant reduction per pass and account for this in residual calculations.*
- *The reason EPA is concerned about residuals management in this FS is because the thickness of residuals impacts the replacement concentration due to dilution and this is driving the time to achieve equilibrium concentrations.*

Path forward:
- *Realistic assumptions for residuals management will be discussed in Meeting #4.5 (modeling meetings).*
- *Following Meeting #4.5 the EWG will evaluate methods for comparing potential residuals management approaches and discuss these approaches with EPA in a Work Product Meeting.*

c. Water management assumptions (Cmts. 229, 247, 389, 390)

Summary of EWG discussion points:
- *EWG does not believe water treatment beyond passive filtration will be necessary for mechanical dredging.*
  - *The EW does not contain PCB concentrations as high as Boeing Plant 2 and Jorgensen Forge, where water treatment was required.*
  - *Recent modeling calculations of dredge elutriate concentrations using Sediment Evaluation Framework methodology (for the 401 Water Quality Certification for the EW programmatic maintenance dredging permit) indicates that surface water quality criteria is not likely to be exceeded with passive filtration.*
  - *Other project experience (e.g., Slip 4, T-117) has shown that surface water quality criteria can be met at the point of compliance using passive dewatering.*
  - *FS text can note the possibility of water treatment requirements; however, additional testing during remedial design and permitting will determine specific engineering assumptions/design for the most appropriate water treatment system for contaminants.*

Summary of EPA Team discussion points:
- *EPA is concerned with PCB hotspots that may be encountered during dredging that may trigger water treatment.*
- *EPA wants water treatment unit costs presented in the FS, even if assumed as a contingency cost.*

Path forward:
- *Additional language will be incorporated into the FS to justify the assumption that water treatment is not likely to be necessary. The FS will acknowledge the possibility of water treatment requirements, as determined during design and permitting.*
- *General unit costs associated with water treatment will be included in the FS based on available similar projects.*

d. <u>Underpier dredging (EPA Alternatives Memo)</u>

Summary of EWG discussion points:

- *EWG wants to confirm with EPA whether all alternatives should contain hydraulic dredging.*
- *It has been demonstrated that hydraulic dredging in underpier areas cannot remove all contamination due to the rock interstices.*

Summary of EPA Team discussion points:

- *The EPA Alternatives Memorandum was not a directive to include underpier dredging in all alternatives. The memo required inclusion of hydraulic dredging in additional alternatives outlined in the memo. It would be acceptable to include both hydraulic dredging and non dredging options in under pier areas for new alternatives.*

- *EPA asks that a range of alternatives be presented in the FS. An example would be for the alternatives with less dredging and MNR in underpier areas, hydraulic dredging could be incorporated as an alternate option, such as the current alternative '3A' (with MNR underpier) and a new alternative '3B' (with hydraulic dredging underpier).*

Path forward:

- *The FS will keep variations of alternatives that are the same in open water areas and different in underpier areas (e.g., MNR vs. hydraulic dredging) so that a direct comparison can be made.*

3. <u>Activated Carbon: Use of in situ treatment and addition of AC or TOC to ENR and RMC (EPA Alternatives Memo; Cmts.7, 15, 23, 27, 187, 226, 256, etc.)</u>

Summary of EWG discussion points:

- *EWG is concerned about significantly expanding use of AC on a broad scale because:*
  - *AC stability concerns: AC is likely to be unstable in the long-term because AC particles are less dense (i.e., more buoyant) than the surrounding sediment particles. Therefore, AC particles are more likely to resuspend and, once resuspended, are slower to resettle. In the long term, some resuspended AC will be transported by both tidal and surface currents away from the remediation area. It is difficult to predict how AC used in open water areas will behave over the long-term in the EW system.*
    Tribes and other stakeholders have serious concerns that AC may pose a risk to the benthic community. Placing higher concentrations of AC to account for resuspension/loss would likely pose risk to the benthic community
  - *Compared to the LDW, the EW has higher bottom velocities and associated scour depths from prop wash due to deeper drafts and more powerful vessels. In the LDW, scour from transiting vessels was calculated to be a maximum of 0.03 ft (1 cm) in the navigation channel and 0.07 ft (2 cm) in bench areas. Scour due to maneuvering during normal berthing activities was calculated to be 0.66 ft (20 cm) or less. In the EW, scour depths due to transiting and maneuvering were calculated to be a minimum of 0.3 ft (9 cm) and a maximum of 4.7 ft (143 cm) depending on the location.*
    FS alternatives include application of AC (up to 12 acres in underpier areas out of 157 acres in the EW) with associated unit costs. Wide-spread application across the waterway will have higher uncertainty in remedy effectiveness than in underpier areas that are subject to lower propwash forces.
  - *AC application in underpier areas may also be applied in a different manner than open water areas due to the underpier slope angles. Underpier AC application was assumed to be placed using one of several proprietary types of material where AC can be applied as part of a coarser mix of material. This same material mix is not appropriate for the open water areas as placement of gravel throughout the open water areas would affect the substrate composition and thus benthic community composition (something the Tribes are concerned with). The draft FS focuses on more proven technologies for wide-spread application.*

- o *Similar concerns are associated with application of TOC:*
  - ➢ *EW sediment has an average TOC content of 1.6%. Mixing in TOC with ENR and RMC will result in constructability challenges similar to AC, because most forms of OC are more buoyant than sand and will resuspend during placement as well as scour events.*
  - ➢ *In Puget Sound, very few projects have been required to place material with OC concentrations similar to existing site conditions. EWG is aware of cap material amended with OC, but not RMC or ENR. Historically, clean maintenance dredge material has been used when trying to place material with similar OC content, however, most maintenance dredge material is no longer considered clean enough to meet applicable chemical standards. It is also challenging to coordinate timing of projects that have material suitable for beneficial reuse. There are also concerns about reliably acquiring clean OC material from upland sources.*
  - ➢ *In Puget Sound, projects typically place sand and gravel material and allow the TOC of the biological zone to re-equilibrate naturally as a result of sediment deposition and mixing, which has been demonstrated at several sites to occur within 1-2 years.*
  - ➢ *Water quality issues (turbidity) are also anticipated for placement of this material. Silt curtains are not feasible with large tides, moving vessels, and 50 foot water depths.*
  - ➢ *A customized application of OC in RMC would be needed and would result in large cost and duration increases (~2-4 times), based on slower production rates for placement of RMC with OC.*
- o *Regardless of whether it is possible to incorporate AC and OC in open water areas, it is unclear how the outcome will be measured because key PRGs (such as PCBs and cPAHs) are evaluated on a dry weight basis in the FS for RAO 1.*
- o *EWG is not aware of past application of near-bottom placement using a tremie tube or submerged diffuser in 50 ft water depth. Achieving uniform thin-layer placement using these technologies in deep water in areas with frequent vessel activity would require specialized equipment, have significant impacts on construction times, and may not be effective. EWG will evaluate further and discuss in a Work Product Meeting.*

Summary of EPA Team discussion points:

- o *EPA notes the FS assumes 50% of sediments under piers are turned over every 5 years. This is not minimal. If there is concern with in situ treatment effectiveness under piers, reduce the effectiveness rating. There needs to be at least one alternative that increases the use of AC in open water areas to see the impact on risk, even if the uncertainty of effectiveness has to be rated higher.*
- o *EPA notes that an evaluation would use an effective dw bulk concentration based on the fraction organic carbon and observed porewater concentration as noted in the EPA Alternatives Memo. More discussion is needed between the EPA and EWG on this issue.*
- o *EPA is aware of the concerns about AC resuspension and suggests proprietary products which adhere rock to AC so that it settles faster and also can be accurately placed at target locations. Also, AC migrating to the sediment surface may be beneficial by reducing bioavailability associated with potential recontamination in the upper layers.*
- o *EPA does not want to rule out AC application to all areas in the FS alternatives because EPA would like to see PCB concentrations be as close as possible to natural background.*
- o *AC costs should be available in the FS and serve as a basis if in the future EPA decides to include AC in other larger alternatives.*
- o *The OC content of the system is important to account for bioavailability and associated risk reduction. A small amount of carbon (OC or AC) is needed to be added to placed material to achieve the equivalent bioavailability of existing OC in the system.*
- o *OC has been added in various locations (Housatonic, Hudson River [crushed coal with sand], West Branch Calumet River). Accurate placement is problematic for water depth in the EW using conventional bucket placement methods, so placement using a tremie tube or submerged diffuser could be used to avoid the loss of OC (with upland premixing before loading). OC will reach equilibrium with the system at some point.*
- o *It is desirable to have similar OC material as native. Using in-water material is not an option, because it is currently not at natural background levels.*

Path forward:

- *The FS may be modified to include some alternatives that incorporate more AC and possibly OC following additional review of the feasibility and value (e.g., effectiveness). The location, type, and amount to be incorporated into the alternative(s) will be dependent on additional evaluation by EWG and reviewed with EPA in a Work Product Meeting. EWG will examine the feasibility of placing OC based on previous case studies, stability, costs, and placement duration.*
- *Additional discussion is required during the Work Product Approval Meeting to discuss the design of alternatives regarding benthic community impacts for both dredging and in situ treatment.*

4. <u>Capping</u>

a. <u>Cap thickness, need for sensitivity analysis of cap design (Cmt. 250, 381, 383)</u>

b. <u>Capping assumptions (where it could be used) (Cmt. 385)</u>

Path forward:

- *EPA and EWG will discuss this topic in Meetings #4 and #4.5 (modeling meeting) and Meeting #5 (remedial alternatives meeting).*

5. <u>Definition of ENR and the use of thicker ENR layers in mixing areas (ENR-nav) (Cmts. 222, 236)</u>

Path forward:

- *EPA and EWG will discuss this topic in Meetings #4 and #4.5 (modeling meeting) and Meeting #5 (remedial alternatives meeting).*

6. <u>ENR and MNR technology assignment assumptions and relationship to sedimentation and practicability (Cmts. 28, 71, 258)</u>

Summary of EWG discussion points:

- *The Draft FS assigns ENR (1-2 acres for alternatives except 2A, which has 18 acres of ENR) and MNR (up to 12 acres) to small areas for select alternatives as part of the FS after considering physical processes, practicability of other technologies, and risk reduction.*
- *Sedimentation isn't the only mechanism for natural recovery and doesn't have to be occurring for ENR or MNR. EPA guidance states that "Natural recovery includes when exposure levels are reduced by a decrease in contaminant concentration levels in the near-surface sediment zone through burial or mixing-in-place with cleaner sediment" (EPA 2005).*
- *Other EW areas with dredging and placement of RMC will reduce concentrations in underpier areas in the long term due to exchange of cleaner open water sediment into underpier areas.*
  - *FS modeling and the Sitcum Waterway case study (Patmont, 2004) indicate that NR in dynamic underpier areas is accelerated following remediation of adjacent open-water areas.*
  - *FS discusses that monitoring is a key element of MNR, which would start at the completion of construction. The FS assumes that if concentrations are still elevated following 10 years of monitoring, contingency actions could be applied. The FS includes contingency actions and associated costs for MNR areas.*
  - *Underpier and underbridge areas are relatively small in area, yet contribute disproportionately to project costs and worker risk if hydraulic dredging is used instead in these areas. The main advantage of hydraulic dredging is mass removal, which may not result in risk reduction.*
  - *EWG wants to understand if the bar is different for including a remedial technology as an alternative in the FS as opposed to selecting a preferred alternative.*

Summary of EPA Team discussion points:

- *EPA may be open to keeping MNR in the FS, pending internal discussion.*
- *If MNR is retained in the FS, then a discussion needs to be included that outlines the specific concentrations that will be achieved in a specific timeframe, and the specific contingency actions that would be used if the goal is not achieved.*

- *If MNR is retained in the FS, then the FS needs to demonstrate that MNR could be effective. Typically multiple lines of evidence are used to show that natural recovery is occurring. The FS should demonstrate the lines of evidence used to indicate that natural recovery will occur in the future.*

Path forward:

  - *EPA will consult internally regarding the use of MNR in the EW. In general, EWG and EPA are in agreement that underpier and underbridge areas warrant comparison of various technologies in the FS.*
  - *More discussion is needed between EWG and EPA as to whether mass removal, associated with hydraulic dredging could result in risk reduction.*

7. <u>Schedule Meeting #7 and #8</u>

Path forward:

- *EPA will provide response to EWG with suitable dates for Meetings #7 and #8.*

EXHIBIT 9

From:	Sanga, Ravi
To:	Dan Berlin
Cc:	Brick Spangler
Subject:	EW FS Topics for further discussion
Date:	Wednesday, May 16, 2018 5:37:18 PM

Dan See below for some of the more major changes EPA will be requiring at part of the Approval with Modifications on the EW FS. Let me know if you want to chat about anything further this week before our meeting next week.

- Remove references to SCUM II information, includes all Ecology natural background and PQL values. SCUM II is not an ARAR and shouldn't be referenced in the FS. When it was appropriate to mention SCUM II, there are revisions to clarify that it is not an ARAR.

- Remove Appendix A, Part 1. To implement removal of the SCUM II references (i.e. Ecology natural background values), significant revisions would be needed for Appendix A. Since compliance with SMS is sufficiently described in Section 9.1.1.2 of the FS, Appendix A Part 1 is not needed. References to Appendix A Part 1 in the main FS text have also been removed or modified.

- Recalculate risks for cPAHs based on the revised benzo[a]pyrene toxicity values.

- Revisions to the ARARs table as directed by EPA council. Several of the citations are incorrect.

- Other clarification revisions.